ENGINEERING NEWS
AND
AMERICAN RAILWAY JOURNAL,

VOL. XXI. No. 17.

TABLE OF CONTENTS.

Engineering News of the Week 371, 372
Technical and Illustrated Articles
Water-Works Records 372
Kennedy's Fire Valve 372
Growth of Population, 1790 to 1880; United States and Canada 373
The Jull Centrifugal Snow Excavator 374
The Improvement of Railway Track 374
The Stuart Elastic Tie Plate 375
Broad vs. Narrow Gauge in India 376
Tables for Power of Compound Pumping Engines 376
Changing the Color of Blue-Prints 378
A Drifting Test for Steel Angle-Bars 378
The Use of Liquid and Gaseous Fuels 378
Gaugings of Sewer Discharge Contemporaneous with Rainfall (*Continued*) 379
The Cove Railway Terminals, Providence, R. I. 380
Road Building 381
Address of the President of the Am. Water-Works Association at the Louisville Convention 387
Weather Report for March 388
Extensions and Additions to Water-Works Systems for 1889 388
Editorials and Ed. Notes 382
The Opening of Oklahoma. The Prospects of Manitoba. Extensions of Water-Works in 1889. Engineers Wanted and Positions Wanted.
A Century of Progress (*With Inset*) 382
Shall They Vote Away the Right to Vote? 384
The Water-Works of the United States and Canada 384
Correspondence 387
Computing the Bevel Angles for Skew Portals. Iron and Steel Compound Bridge Pins.
Personals. Publications Received. Society Proceedings 388, 389
Railways. Rapid Transit. Contracting. Proposals Open. Manufacturing and Technical. Bridges and Canals. Electrical. Water and Municipal 390, 394

ENGINEERING NEWS.

THE INTERSTATE COMMERCE COMMISSION has published its ruling in the case of the Grand Trunk Railway Company, charged with carrying coal for less than its published rates between points in the United States and points in Canada. The Grand Trunk company freely admitted the acts in question, but denied that its traffic from points in the United States to points in Canada was within the jurisdiction of the Interstate Commerce law, and also that the acts were injurious to any one. The Commission held that the law has full control over traffic from points in the United States to points within an adjacent foreign country, and that the acts of the Grand Trunk Company were therefore in violation of the law. The fact that no specific complaint of injury was made did not alter the case in any way, and an order was issued requiring the company to cease the illegal acts in question.

THE BALTIMORE & OHIO SHOPS at Mt. Clare, Md., are under discussion by the company's managers. Contracts have recently been let to outside locomotive builders for about 50 locomotives, and at the last monthly meeting of the directors Senator GORMAN offered the following resolution:

Resolved, that it is inexpedient to discontinue the construction of engines and cars at the shops of the company, but that the interests of the company as well as of the State of Maryland and the city of Baltimore will be promoted by using such shops to their full capacity for construction and repairs up to the demands of the company.

A substitute resolution offered by Mr. FRICK was finally adopted, postponing the adoption of any definite policy regarding the Mt. Clare works until the report on their condition and capacity, now in preparation, is submitted.

COMPETITION AMONG CONTRACTORS for railway construction is very sharp at present. Over eighty contractors put in bids for building the 100-mile section of the Pacific Short Line, at the recent letting at Sioux City, Ia., and 125 different proposals were considered. The successful contractors, E. P. Reynolds & Co., of Wymore, Neb., must feel considerable elation at their success over such a crowd of competitors. It is stated that additional contracts are soon to be let.

A FAST RUN is recorded on the New York, Providence & Boston R.R., on Apr. 19. The train was the New York and Boston express and consisted of engine, tender, combination car, day coach, two parlor cars and a dining car. The train was delayed three hours at Stony Creek by a derailed engine, and at Groton, Conn., engine No. 34 was attached and it was attempted to make up time. The run to Providence, 62¼ miles, was made in 68 minutes without a stop. From Wickford Junction to East Greenwich, 6 miles was made in 6 minutes, according to press reports. The engine has 18 x 24-in cylinders and 6-ft. drivers.

LOCOMOTIVE BUILDERS are again complaining of low prices. The Vandalia has recently purchased some engines of the Pittsburg Locomotive Works weighing 105,000 lbs. at a cost of $9,000.

COMMISSIONER CAPPELLER, of Ohio, has sent a circular letter to the railways of the State calling attention to the necessity for gates and flagmen at dangerous grade crossings and the use of foot guards at switches.

THE SOUTH PASS JETTIES, at the mouth of the Mississippi river, having already accomplished so much more than was originally promised by Capt. EADS, the New Orleans *Times-Democrat* wants the Government to now open the Southwest Pass and establish a permanent 45-ft. channel between New Orleans and the Gulf. Our contemporary founds this request upon the fact that the Government proposed to use the jetties already built simply to test the feasibility of Capt. EADS' plans; and promised, if they were successful, to then open the Southwest Pass, which has a normal depth of 60 ft. throughout its entire length, and 15 ft. over the bar.

THE SUNDAY REST MOVEMENT is extending. On and after April 28 the Vanderbilt lines will run no freight trains between 6 P. M. Saturday and 6 A. M. Monday except when absolutely necessary for the transportation of live stock or perishable goods.

DULUTH WINS ANOTHER POINT, as the Board of Managers of the Interstate Railway Association have voted to grant the application of the Chicago, St. Paul, Minneapolis & Omaha company to make the same rates to Duluth from Omaha and all points in Nebraska on and north of the Union Pacific as is now made from the same points to Chicago.

AN IRRIGATION PROBLEM of importance is now before the California courts. A suit has been commenced by the Spring Valley Water Co., of San Francisco, to question the right which the law now gives all boards of supervisors to arbitarily fix the rates at which private water companies must supply their consumers, though the law fixes no other basis for these rates than the very vague expression "with reasonable profit to the water company." The complaint is made by the above company that the supervisors of San Francisco have cut down their rate to a figure which will not afford one-half the revenue needed to pay expenses and a reasonable dividend on the capital stock, that no pains has been taken by the supervisors to inform themselves of the cost of supplying water, and that the company was denied the privilege of producing its books and accounts in evidence. The very valid claim is made that the storage and distribution of water for irrigation and domestic purposes requires large capital; and investment in this direction can only be secured by a legal assurance that the company's revenue will not be dependent upon the mere whim of any board, unchecked by law. Rumor has it that the present difficulty arises from the non-delivery of expected boodle. But whether so or not, the law should be so revised that a dishonest board would be deprived of such power, and an innocent board be placed beyond the possibility of such a charge.

THE SHEFFIELD SCIENTIFIC SCHOOL, by the late death of Mrs. JOHN EARL SHEFFIELD, inherits the "homestead" property valued at $250,000, and an interest in other property which will increase the bequest to nearly $600,000. Mr. SHEFFIELD, in 1860, gave to the Scientific Department of Yale the building now known as South Sheffield Hall, and the amount named above will enable the college authorities to increase their facilities and perhaps establish the desired four years' course.

THE NEW TOWER BRIDGE, over the Thames in London, has so far advanced that tenders are invited, until May 10, for the delivery and erection of the iron and steel superstructure. Mr. J. WOLFE BARRY is the engineer.

AN ARTESIAN WELL, 1,406 ft. deep, has been bored in Cunnamulla, Queensland, with a resulting flow of 450,000 galls. per day. Such an abundant flow of water in a hitherto barren region opens up to government and private enterprise great possibilities in other parts of the Colony.

A SHIP CANAL, connecting the Ohio river and Lake Erie, is the subject of a bill now before the Pennsylvania Legislature. The bill proposes to appoint a commission of three civil engineers, who are to survey and report upon the scheme. One object of the proposed canal would be to better connect the Michigan ore-fields with the furnaces of Western Pennsylvania.

THE GOVERNMENT OF NEWFOUNDLAND contemplates the construction of 250 miles of railway with a view to making the mining districts, and certain tracts of land said to be capable of agricultural development, more readily accessible. Newfoundland has at present 85 miles of 3-ft. 6-in. gauge worked by a company aided by a Government subsidy, and it has opened for traffic a branch line 25 miles long, built and operated by the Government. These facts are given on the authority of Mr. H. C. BURCHELL, Government Engineer of Newfoundland.

THE MOST SERIOUS RAILWAY ACCIDENT of the week occurred April 20 on the Central Iowa Railway, 4 miles west of Abingdon, Ill. The derailed truck of a freight car in a mixed train spread the rails, causing the passenger cars to leave the track: the train ran on about 100 ft. to a trestle across Cedar creek, where the two passenger cars (one of which was used as a mail car) went down the 30-ft. bank. The mail car caught fire, and the car and trestle were burned. One man was killed and 5 seriously injured; 1 passenger is thought to have been burned in the wreck.——On April 22, a Boston & Albany freight train broke in two near Worcester, Mass., and the two sections collided, causing a bad wreck: some oil cars caught fire and 4 freight cars were burned.——At Redding, Cal., a passenger train was ditched by a misplaced switch April 14, but fortunately without serious results, although the place of the accident was close to a dangerous precipice.——On April 18 a car jumped the track on the Tennessee river bridge at Decatur, Ala., but the train was stopped before any damage was done beyond the tearing up of some ties and part of the guard rail.

COMPETITION OF CANADIAN RAILWAYS with American lines is to be investigated by the United States Senate Committee on Interstate Commerce at a session to be held in this city next week. A fight is prophesied between the Wall Street trunk line magnates, and the merchants and shippers of Western cities, especially those situated near the Canadian boundary. The latter claim that the competition of the Canadian lines is an important factor in preventing overcharges by the American trunk line railways.

BRIDGE ACCIDENTS are reported as follows: On April 14, a railway bridge 30 ft. long and 15 ft. high, over Wea creek, near Crawfordsville, Ind., was damaged by fire. A train was flagged in time to prevent an accident.——On April 22 a derailed freight train broke down the Third creek bridge, near Salisbury, N. C., on the Western North Carolina Ry., and 13 cars went into the creek.

THE CAUSE OF THE FAILURE of the Verrugas Viaduct is now reported to have been a landslide from the precipitous rock sides of the gorge, apparently induced by a terrific storm, and made possible, it is likely, by too careless trimming of rock slopes.

A SAND STORM filled a cut on the Oregon Ry. & Navigation Co.'s road near Celilo, Ore., April 11, and stopped traffic for several hours.——A landslide occurred in Black cañon, near Montrose, Col., on April 18; a passenger train ran into the obstruction, and the engine was thrown into the river. One man was killed.

THE ACRE-FOOT is a new irrigation term devised last season in the Government Department controlled by Maj. J. W. POWELL. It means an acre of water 1 ft. deep, and it will, on an average in the United States, irrigate for the season 1 acre of land.

THE VISITING ENGINEERS from this country seem likely to be hospitably treated in England, as indeed was to be expected. A formidable list of about 150 members of a "reception committee," formed exclusively of members of all classes of the Institution of Civil Engineers, lies before us, and the Iron & Steel Institute and Institution of Mechanical Engineers have, we believe, formed similar committees. The formal features of their welcome will consist chiefly of a reception in Liverpool and a reception and dinner in London, with "chalked hats" for a good part of their railway travel; but beyond this there will no doubt be many less formal, professional and personal courtesies extended to them.

THE ROCK ISLAND prints the following on its published tariffs filed in Iowa:

The rates named in the schedule are unreasonably low and are accepted only for the purpose of avoiding harassing and vexatious litigation threatened by the railroad commissioners of the State of Iowa pending the settlement of the important questions by the Supreme Court of the United States.

Water-Works Records.*

There are few, if any, connected with water-works management, who have not, at some time, felt the need of more complete records of work done, especially if managing works designed, built, and previously managed by others. Very much the larger part of a water-works plant is buried out of sight, but by no means out of mind, for there is no joint, corporation cock, or any other fixture buried five or more feet below the surface of the streets but what, at the most inopportune time, may make its presence felt and require immediate attention. Therefore, the great need that the maps, plans, and records of such work be very complete, so that from them we or our successors may at all times know what is buried in the streets and just where to dig for it. They should be so clear and explicit that any one could fully understand them; for we do not build for the present only but for all time.

In building new works, the first thing determined upon is the source of supply. Then a correct map of the city or town to be supplied, is required. And all through the history of the works this map will play a very important part.

The map being obtained, the pipe system is laid out upon it, and in doing this the future needs should be considered as far as possible.

After determining the amount of water needed at all points, for domestic use, manufacturing, fire protection and probable waste, and *guessing* at the growth in various directions, the sizes of pipes required will be determined upon and the pipe system laid out on the map For quick and easy reference, different colors and forms are usually used to indicate the different sizes of pipe. In selecting these colors and forms, it will be found convenient to select the most simple ones for 6-in. and 8-in. pipe these usually forming the larger part of the pipe system

This plan of the pipe system should not only show mains to be laid at the time, but also an outline of proposed extensions. And in making these extensions, when needed, this plan should be rigorously followed. Unless future developments make an increase in size necessary, it should never, from false motives of economy, be reduced.

Gate valves and fire hydrants should next be located and marked on the map, particular prominence being given to the latter for the convenience of firemen and insurance men.

In making the survey, it will not be much extra work to take levels, which should be indicated on the map, using fire hydrants as grade stakes. The quantity of water the mains are capable of delivering at various points, with the required pressure, should also be noted on the map, though for this purpose some form of table would probably be better. For myself, I have never been able to devise a satisfactory form.

We shall now have a complete picture of the works, and a plan for future developments. But useful as this undoubtedly is, in fact almost indispensable, it is necessarily, except in the case of very small towns, on too small a scale to show much of the details. For this purpose, other maps and plans on a much larger scale must be made. This is usually done by dividing the city by wards, or some other convenient division, and making a separate map of each section. These maps, for convenience, are bound in book form.

I have, to some extent, used a form of map which I can recommend to others having cement-lined, wood, or other makes of pipe that frequently have to be replaced in places with cast-iron. That is, a map for each street by itself. For these maps, or rather plans, I use a long strip of heavy tracing cloth, 9 ins. wide—drawing the plans to a scale of 24 ft. to an inch—thus representing our 48-ft. street by 2 ins. space on the map, giving ample room for entering all necessary details. Judging from the little experience I have had with this form of map, it strikes me that it would be excellent for a whole system, as it is capable of showing every detail of the mains, etc., that can be desired. The exact location of the pipes at every point, the location of valves, unconnected branches, corporation cocks, and if thought necessary, the position of every joint, can be clearly shown. The uses to which such detail maps can be put are many.

In addition to a clear plan of the mains and other fixtures in the street, the property lines can be shown; lots built upon being distinguished from vacant lots by coloring or otherwise, and those supplied with city water by some mark which will show the proportion of houses on each street supplied with city water.

I use for this purpose a city atlas, showing property lines, and indicate premises supplied with city water by application number, thus making the map serve also as an index to the Application Book; and a very handy index it is, often coming to the rescue when all others fail. The "Application Book" referred to is a permanent book, one application serving for the premises through all its changes of ownership, etc.

On one page of this book is a blank form of contract for water supply, which is filled in and signed by owner of property before water connection is made, and is so drawn as to be binding to his heirs or successors. This page also contains space for keeping a record of fixtures and rate. This is kept in pencil, to admit of change whenever additions are made to the plumbing. The opposite page is blank, and on it is kept a complete history of the "tap." On this page is noted such items as name of plumber who puts in service and plumbs premises; length of service, with a diagram of the location of stop-cock box; changes of ownership and tenants; additions to plumbing and when made and by whom. It is in fact made, so far as the water supply is concerned, a complete history of the premises.

When new mains are to be laid, a map on the single street plan will serve as a working-plan for the foreman. And on it, as the work progresses, measurements of unconnected branches and of location of valves should be noted, and also the make of valves and hydrants, if more than one kind is used in the works; and kind of pipe, if any except cast-iron is used. When the main is completed, the date that water was turned on, together with any other item of interest connected with it, should be noted.

For location of valves, something even more explicit and accessible is needed, as they are sometimes needed in a great hurry. Diagrams, not necessarily drawn to a scale, of the location of each valve, giving figures for distances, will be found useful. They should be made in a strongly bound book, of suitable size to be carried in the pocket of superintendent or foreman, and accompanied by a written description. As such diagrams are easily and cheaply made, every man connected with the works who is to be intrusted with the use of the valve key and is liable to be called upon to shut off the water, should be supplied with a copy.

To show what valves are needed to shut off a given district and where to find the diagrams of their location, each book of diagrams should be accompanied with a small map; one drawn to a scale of 800 or 1,000 ft. to an inch will answer and will be small enough to carry in the book. The streets should be shown by mere lines; those having mains by red ones, others by black; and the valves by numbers corresponding to the numbers of diagrams in the "Valve Book."

With this book of diagrams and map, each man has ready at hand the means of quickly finding all valves necessary to shut off any part of pipe system, which is often important; for instance, in the case of a bad break, let us say in winter, when in the north our valve-box covers are buried under a foot or two of snow and ice, making it impossible to find them, without exact measurement.

The most convenient and accurate measurement is by two diagonal lines taken from prominent objects on opposite corners of streets. I usually select the lamp-post and fire-hydrant as being the most prominent and permanent objects.

The best device I have seen for mounting large maps is the one in the Buffalo, N. Y., Water Department. It is the invention, I believe, of Mr. GEO. E. MANN, City Engineer. It consists of two rollers secured to the back of a drafting board and connected together by gearing, so that they turn in opposite direction; the ends of the paper are wound upon these rollers, the part on which the map is drawn being exposed on the surface of the board, enough of the paper being wound upon each roller to allow for the required movement of the board in either direction. By turning a crank attached to one of the rollers, the map is drawn in one direction and at the same time pushed from the other, thus bringing any part of the map in convenient position for examination or work, without any strain on the paper.

In undertaking to write this paper, it was my intention to collect and describe the various forms used in water offices, for applications, plumbers' permits, account of water rates, etc. But the great variety which I found in these forms made the task a very difficult one, and would have made this paper entirely too long. So I leave this subject for some one else in search of material for a paper, and will guarantee that he will find a plentiful supply.

*A paper by J. M. DIVEN, of Elmira, N. Y., read at the Louisville, (Ky.), Convention of American Water-Works Superintendents, April 16, 1889.

Kennedy's Fire Valve.

It is often a matter of vital importance to know that valves used in connection with sprinklers and hydrants for fire protection are open, and not merely supposed to be open. In the ordinary form of valve mere inspection is of no value to satisfy the user upon this point unless inspection is carried to the extreme of an actual flow of a water, a measure by no means safe or convenient under all circumstances.

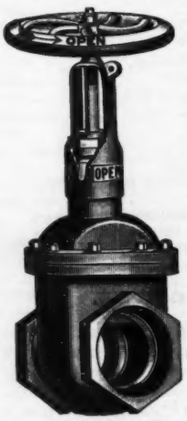


Fig. 1. "Open."

But by a slight and inexpensive detail added to the ordinary valve the inventor of the device here illustrated has very effectually overcome the difficulty. This improvement is applied by providing the bonnet of the valve with a cylindrical boss, in which latter is cut or milled a longitudinal groove. On each of two opposite faces of the boss the words "open" and "shut" are presented in large letters, one above the other, with the spaces between the letters sunk, but the letters themselves conforming to the general cylindrical exterior of the boss. This boss is loosely enclosed by a strong movable sleeve, provided with a pin projecting inward and engaging in the longitudinal groove.

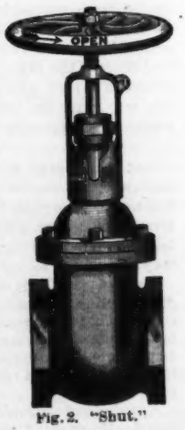


Fig. 2. "Shut."

The operating spindle of the valve itself is provided with a fine screw-thread, just under the hand-wheel, upon which is a screw-threaded yoke forming part of the sleeve. This simple device insures that the sleeve will be raised or lowered to a small extent with each turn of the main spindle, and this motion is so arranged as to completely uncover one or the other of the two inscriptions and show the word "shut" when the valve is closed, and "open" when the valve is open. By the use of raised letters it is possible to ascertain the condition of the valve in the dark.

The present improvement was devised by Mr. DANIEL KENNEDY at the request of Mr. JOHN R. FREEMAN, of the Boston Manufacturers' Mutual Fire Insurance Co., to whose experience and judgment the public are indebted for a number of valuable suggestions as to complete and prompt protection against fire. The valves themselves are manufactured by Mr. DANIEL KENNEDY, 52 Cliff St., New York City.

Growth of Population, 1790 to 1880, United States and Canada.

The accompanying large table was prepared for constructing the diagram of growth of population which appears in this issue. As such a table has never been published or compiled before, to our knowledge, and as the figures have a special interest at this centennial season, we reproduce it, and we have likewise computed the smaller table (Table II.)

It is at least quite certain that the Far West, beyond the Mississippi river, will show an enormous rate of growth in 1890, perhaps even larger than the great increase of the last two decades (60.6 and 67.8 per cent.) It is to be remembered, of course, that all the earlier percentages, when population was very small to start with, are quite abnormally large, and are never maintained after the population has reached a reasonably large figure. When the population is only 1, a single other settler causes 100 per cent. increase.

TABLE I.

POPULATION OF EACH GROUP OF STATES OF THE UNITED STATES AT EACH DECENNIAL CENSUS, 1790 TO 1880 INCLUSIVE.

[Kansas is included with the Northwestern Group. Otherwise the grouping of States and Territories is the same as shown on the map accompanying the diagrams in this issue.]

GROUPS OF STATES.	1790.	1800.	1810.	1820.	1830.	1840.	1850.	1860.	1870.	1880.
South Central	109,368	335,407	785,146	1,343,178	2,031,708	2,927,856	3,881,033	4,728,993	5,131,360	6,525,097
South Atlantic	1,472,982	1,896,580	2,197,648	2,547,671	3,083,130*	3,334,483*	3,952,837	4,490,358	4,816,001	6,398,022
North Central	.....	51,006	272,324	792,400	1,470 018	2,924,728	4,523,260	6,926,884	9,124 517	11,206,658
Middle	1,337,456	1,822,479	2,491,945	3,210,182	4,153,286*	5,120,076*	6,624,988	8 331,330	9,848,415	11,756,053
New England	1,009,408	1,233,011	1,471,973	1,659,579	1,957,035*	2,237.922*	2,728,116	3,135,283	3,487,924	4,010,529
Total E. of Mississippi River	3,929.214	5,308,483	7,219,036	9,553,010	12.695,177	16,545,065	21,710,234	27,614,848	32,408,217	39,836,369
Southwestern	.....	.....	20,845	80,312	170,843	181,276	1,166,080	2,349.479	3,156,083	4,876,546
Northwestern	.....	.....	.....	.....	.....	43,112	198,291	987.820	2,165 012	4,049,011
Pacific	.....	.....	.....	.....	.....	.....	117,371	491.183	829,059	1,393,857
Total West of Mississippi River	.....	.....	20,845	80,812	170,843	524,388	1,481,642	3,828.473	6,150,154	10,319,414
Total U. S.	3,929.214	5,308,483	7,239,881	9,633,822	12,866,020	17,069,453	23,191,876	31,443,321	38,558,371	50,155,783

*In 1840, 6,100 sailors in U. S. Navy; divided 1,000 to So. Atlantic, 2,000 to Middle, 3,100 to New England.
In 1830, 5,318 " " " " " " " 2,318 " "

showing the *percentage* of growth in population of each section in each decennial period. The United States census records are given only for individual States; and there are so many of them that it is almost impossible to study in them general tendencies. By grouping the States into 8 main groups, 5 of which are east and 3 of which are west of the Mississippi river,* this is readily done.

The population of the colonies which now constitute the Dominion of Canada has not been taken at regular decennial intervals during this period, nor is it known at all with exactitude prior to 1806. At that date and since, its population has been as follows, according to the official "Statistical Record of Canada" for 1887:

	Population	Dec'l. rate of increase.
1806	455,899	
1834	1,302,961	49.8
1844	1,802,889	38.4
1851	2,547,158	63.8
1861	3,174,442	24.6
1871	3,635,024	14.5
1881	4,324,810	19.0

The population of the two chief provinces of Canada, Ontario and Quebec, is known from an earlier date. It was in 1806, 320,718, or a little more than two-thirds of the then population of the present Dominion, and at two prior dates was

1784.....113,012
1791.....161,311
1806.....320,718

This shows a much more rapid rate of growth than occurred after 1806, which is due chiefly to a heavy loyalist or tory emigration from this country which continued for some years after the war, and was provoked largely by unwise measures of confiscation and social ostracism. The descendants of these emigrants constitute to-day the most important part of the population of Ontario. The total of such emigration is variously estimated at 40,000 to 60,000, and at the rate of increase by excess of births over deaths which is found to obtain in the United States, 2 per cent. per annum, or a trifle under 22 per cent. (21.9) per decade, their dessendants alone should now number from 240,000 to 360,000. The population of 1784 was almost wholly French.

The population of the United States as a whole increased, with marvellous exactitude, a shade under 35 per cent. (34.61) per decade between 1790 and 1860. The civil war caused a sharp falling off. Had the rate of the preceding decade been maintained, the population in 1870 would have been 42,630,000 instead of 38,558,000, a loss of 4,072,000. In 1870-80 there was a recovery to nearly the former rate of decennial growth, and we are disposed to believe that the census of 1890 will show a still further increase, if not an even heavier percentage of growth, than has ever before occurred. A multitude of facts point in that direction.

*The State of Louisiana, which lies mostly west of the Mississippi river, is included in an eastern group, as shown on the map, but most of its population lies east of the river, and this is the only State cut in two by it.

The vast district east of the Mississippi, which until after the war included nearly all our population, shows a slight but steady tendency to decrease in rate of growth, due, of course, to the heavy and increasing emigration to the West, but the rate is even now slightly above the natural rate of increase. The South Atlantic and New England groups show the lowest and nearly equal percentages of increase, until the last decade, where some large errors of omission in the census of 1870 caused an abnormal rate of apparent growth in the 1880 decade, in the South Atlantic and Central groups. We have indicated in parentheses more probable figures, which give the same aggregate growth between 1860 and 1880. We are of opinion, however, for reasons apparent from Table II., that the South Atlantic group at least, was never properly enumerated until 1880, but that there have been large errors of omission for several censuses. Very likely this is true also of the South Central group.

Canada shows from 1806 to 1851 an average rate of increase in population of no less than 46.57 per cent. per decade. It is altogether probable that a part of this heavy ratio is deceptive, and due to errors of omission in the earlier censuses, but it would require a population in 1806, of 660,000, instead of the 455,899 actually reported, to bring the ratio of increase down to that of the United States, 35 per cent., and it is therefore probable that up to 1851 the percentage of increase of population in Canada was even greater than in the United States. Since 1851 a sharp change has taken place, due to emigration of Canadians to the United States. The 1880 Census showed 717,157 natives of British America born in the United States, and including those born in the United States since 1851, of Canadian emigrants, there were some 1,100,000. Curiously enough, if we assume Canada's natural growth of population since 1851 to have been at the same rate as that of the United States (and Canada has been receiving many immigrants) it accounts for almost exactly this loss. At that rate, the population in 1881 should have been 5,508,600 instead of 4,324,800, a difference of 1,183,800, or 21½ per cent.; in other words, more than one-fifth of Canadian natives find it advantageous to emigrate to the United States. Of these emigrants there were in 1880, 34 per cent. in New England, 14 per cent. in the Middle States, 33 per cent. in the North Central States (over half of them in Michigan), and 19 per cent. in the other States and Territories, showing that the Canadians chiefly come in to the easterly States, taking the place of those who emigrate thence to the West, instead of starting out themselves for that land of promise.

TABLE II.

PERCENTAGE OF DECENNIAL INCREASE IN POPULATION, 1790-1880; UNITED STATES AND CANADA.

[The war decade is included between black column lines.]

GROUPS OF STATES.	1790-1800	1800-1810	1810-1820	1820-1830	1830-1840	1840-1850	1850-1860	1860-1870	1870-1880
South Central	206.8	134.1	71.1	51.3	44.1	32.8	21.6	(11.0) 8.5	(21.6) 27.2
South Atlantic	26-7	17.8	15-9	21.0	8.2	18.5	13.6	(13.0) 7.3	(74.9) 31.6
North Central	.....	433.9	191.0	85.5	99 0	54.7	53.1	31.7	22.8
Middle	36.3	36.7	28.8	29.4	23.3	29.4	25.8	18.2	19.4
New England	22.2	19.4	12.7	17.9	14.4	21.9	14.9	11.2	15.0
Total E. of Mississippi R.	35.1	36.0	32.3	32.9	30.3	31.2	27.2	17.4	22.9
Southwestern	.....	.....	287.7	111.4	181.7	131.9	110.5	34.3	54.5
Northwestern	.....	.....	.....	.....	.....	359.9	398.2	119.2	87.0
Pacific	.....	.....	.....	.....	.....	.....	318.8	68.8	68.1
Total W. of Mississippi R.	.....	.....	287.7	111.4	206.9	182.6	158.4	60.6	67.8
Total United States	35.10	36.38	33.07	33.55	32.67	35.87	35.58	22.63	30.07

		1806 to 1834	1834-1844	1844-1851	1851-1860	1861-1871	1871-1881
Canada	.....	49.76	38.38	63.84	24.63	14.51	18.98

(The Canada records are not exactly decennial, but the percentage given is the decennial rate, equivalent to the actual rate for the given period between censuses.)

The statistics given for the different groups will well repay further study by those wishing to understand the facts as to the growth of this country, but we cannot attempt to further aid them.

THE COPYRIGHT OF THE EIFFEL TOWER was claimed by the builder, not only for all photographs and engraved views, but also for all reproductions of the tower in the shape of jewelry or mementoes in metal, wood, stone, ivory, etc. The opposition argue that this claim is absurd, that the tower is built on the city land, that the State has appropriated $300,000 toward the work, that it forms part of the coming Exhibition, and belongs alike to all Frenchmen. The matter in dispute was referred finally to the Commerce Committee of the Conseil d'Etat, and this body has decided against Mr. EIFFEL'S claims and his right to farm out the privilege of reproduction. The ground taken is that it is a public monument, that it belongs to the State during the exhibition, and will belong to the City of Paris thereafter, that while Mr. EIFFEL is the builder he is not the proprietor, and that he can only exert the rights actually enumerated in his concession.

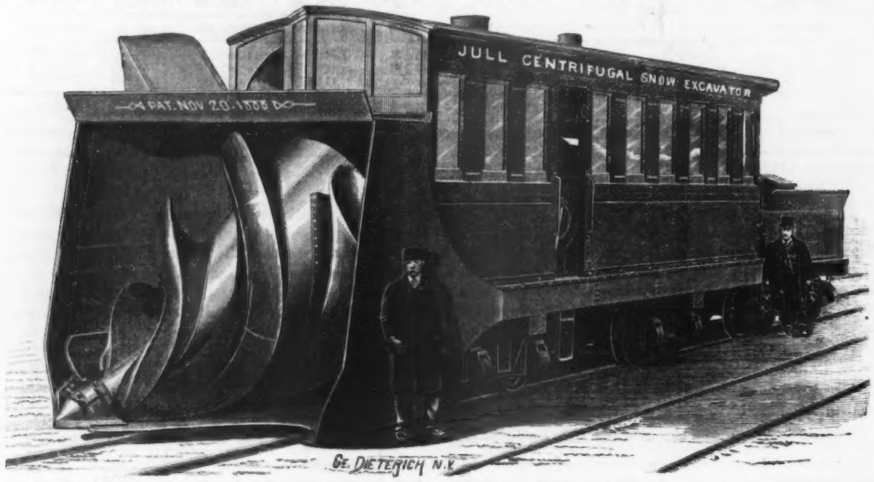
A MUTUAL INSURANCE ASSOCIATION for the benefit of employés of the Pennsylvania system on lines west of Pittsburg and Erie is soon to be established.

The Jull Centrifugal Snow Excavator.

We published in our issue of March 30, 1889, a view of the mechanism of this latest achievement of Mr. ORANGE JULL, of Ontario, Can., the inventor of the original rotary snow plow, which has rendered such excellent service. We now supplement the account of it which we then gave by a view showing the completed machine ready for work.

The extreme height of the machine illustrated is 13 ft. 6 ins.; length, 42 ft.; weight, 65 tons. The height of the front hood only is 10 ft. The velocity of the cone in service is 180 to 300 revolutions per minute. For further details we refer to our former article, but a few particulars of the tests of the machine (which was only completed late in the winter) are as follows:

On March 6, 1889, on the Rome, Watertown & Ogdensburg R. R., at Oswego, N. Y., it cleared 750 ft. of track, covered with hard frozen snow varying in depth from 2 to 7 ft. The snow was



The Jull Centrifugal Snow Excavator.

thrown a distance of 60 ft. It was a particularly severe test, by reason of the fact that the snow had been lying upon the siding during the entire winter, and was nearly as hard as solid ice. Some of the pieces of ice thrown out were afterwards weighed, and one was found which weighed 75 lbs., something that would appear quite impossible to handle with Mr. JULL's original rotary plow.

On March 9, the excavator cleared a siding upwards of 900 ft. in length, filled with hard snow varying in depth from 2 to 8 ft. The time consumed was not taken on either of the above occasions, but the excavator worked steadily and without any stoppage whatever.

On March 11, 1889, a third exhibition was made at Oswego. In this case the excavator was timed, and exact measurements were taken by railroad officials present of the length of cut and depth of snow.

The length of the cut was 720 ft.; average depth of snow 7 ft., varying from 18 ins. to 10 ft.; the width of space cleared 10 ft. This cut was cleared of snow, and the rails left clean, without the use of flangers, in 7 minutes' time. The motive power was furnished by two passenger locomotives one 16 x 22, and the other 17 x 24. The number of revolutions of the bladed cone did not exceed 180 per minute, although its full speed exceeds 300 revolutions per minute. In all, the excavator cleared in 7 minutes, 50,400 cu. ft. of snow, or 7,200 cu. ft. per minute.

The distinctive features of the device may be briefly summarized as follows:

1. The diagonal arrangement of the bladed cone, so that its apex is at the lower right-hand corner of the hood, while the base is at the upper left-hand corner. By this arrangement the curved blades of the cone operate directly upon and slice off the face of the snow bank, from side to side of the hood, without any direct resistance whatsoever, except that of the straight sides of the hood.

2. The curvature of the blades is much greater toward the apex of the cone than toward its base, so that in their first contact with the snow the blades operate as an augur. As the velocity of the cone in its revolution increases toward its base, by reason of its increasing diameter, the centrifugal force generated is correspondingly increased, so that the snow gathered in by the curved blades has velocity gradually imparted to it, and is thrown out without the necessity of fan blades, other than the blades of the cone itself. Thus the snow is sliced off and discharged in one operation, by means of a single mechanism, the absolute simplicity of which is certainly a most valuable feature.

3. It is claimed to be impossible to choke the hood or blades of the cone with snow. It always comes out of the snow absolutely clean, with its blades free from snow.

4. The power to operate the bladed cone is supplied by an 800 H. P. boiler, containing 220 2-in. flues. The engines consist of two 18 x 24 cylinders.

5. The snow may be thrown to either or both sides of the track without reversing, and in fact, changed from one to the other without stopping. To quote from our former article: "There is no double direction of revolution, no reversion of knives, and no closed box to hold snow back of the mechanism which first attacks it."

The price of these plows is the same as that of the original rotary, $15,000, and they are manufactured by the Jull Manufacturing Company, GEO. H. HOBART, President, Brooklyn, N. Y.

The Improvement of Railway Track.

The following is the substance of a paper by Mr. E. E RUSSELL TRATMAN, which was read at the recent meeting of the Association of North American Railroad Superintendents, and which had been prepared at the suggestion of the secretary of the association. The paper has been referred to the Committeee on Roadway.

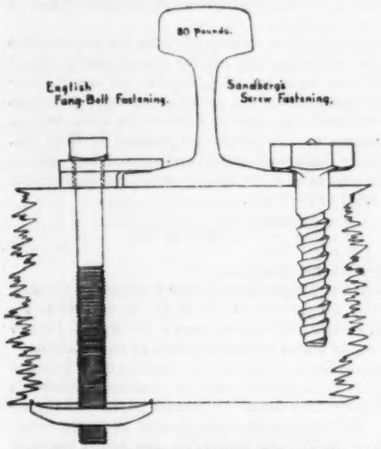
In regard to heavy rail sections, the writer expressed himself as decidedly in favor of heavy rails for main lines, and in fact for all lines carrying a heavy traffic, as such rails give a better track and are really more economical than light rails. It is only within the past few years that much attention has been given to this question, but there is already a decided movement in favor of heavy rails for trunk lines, although light rails will still continue to be extensively used on roads distant from the centers of heavy traffic. A large proportion of the heavy through traffic is hauled over rails of 56 to 65 lbs. per yd., but rails of 70 to 75 lbs. per yd. are being adopted on many roads, and even heavier sections are in use. Among the latter are the New York Central & Hudson River, with an 80-lb. rail; the Pennsylvania, with an 85-lb. rail; and the Philadelphia & Reading, with a 90-lb. rail. The Michigan Central has recently, after much investigation, adopted a standard 80-lb. rail. Considerable attention has of late been paid to the designing of sections for heavy rails, and some very important papers relative to this matter have been written by members of the American Institute of Mining Engineers. The Bethlehem Iron Co., which rolls the Sayre rail, a 76-lb. section of which is in use on the Lehigh Valley, has designs (which were prepared by Mr. ROBT. SAYRE) for rails of this pattern to weigh 84, 92, 101 and 110 lbs. per yd. The weight is but a preliminary consideration; and having decided upon the adoption of a heavy rail, then follows the very important question of how to distribute the metal so as to obtain the best results for strength and wear, and to avoid using any of it as mere dead weight, while at the same time it must be borne in mind that it is desirable to keep all parts of the section at practically the same heat while rolling. The weight of evidence thus far seems to be in favor of a section of the general form of the 80-lb. rails of the New York Central and the Michigan Central roads, having broad and comparatively shallow heads. The Committee of the American Society of Civil Engineers on The Relation of Railway Wheels and Rails, has asked for an expression of opinions as to the recommendation of a rail-head similar to that of the new Michigan Central standard. This rail is 5 ins. high, with a flange 5 ins. wide; the head is 2½ ins. wide with vertical sides and with top corners of ¼-in. radius; the radius of the top table is 12 ins. Rails in different countries have had top tables of 6 ins. to 18 ins. radius, but a radius of 12 ins appears to be most generally used. Mr. WHITTEMORE, Chief Engineer of the Chicago, Milwaukee & St. Paul, advocates a broad top perfectly flat, with a wheel having a wide flat tread. The Sayre rail is of a very different style from those above described, having a large proportion of the metal in the head, and the sides of the head flaring outward from the top.

An important point in relation to track, which seems to be very generally neglected, is that of the fastening of the rails to the ties. The spikes now in universal use do not make an efficient fastening, but while much has been done towards the improvement of rails, joints, etc., the rail fastening continues to be generally used in its original form. The Committee on Roadway (of this Association) in its report in 1888, recommending that it be given power to consider and report upon rail sections, rail-joint fastenings, etc., made no mention of the rail fastening. When a heavy rail has been adopted, then the question of its fastening to the ties should be given careful consideration, as the ordinary spike, which cannot securely hold ordinary rails, will be inadequate for high and heavy rails. In Europe, bolts and screws have been used for fastening rails of the American type; but in this country the Bush interlocking bolt is almost the only improvement on the spike which has met with practical success, and even that is not in use to any great extent. An objection to bolts is that they necessitate the boring of holes in the ties, which causes an expenditure of time and money, but there should be little trouble for maintenance after the track is once in good condition, as the bolts can easily be screwed up by the trackmen with a special wrench. A screw fastening, however, would be simpler and probably as efficient; such a fastening is used with Mr. C. P. SANDBERG's 110-lb. "Goliath" rail on the Belgian State Railway. A drawing, which we reproduce, was presented, showing an English fang-bolt fastening, and the Sandberg screw fastening applied to an 80-lb. American rail. The writer did not intend to recommend either arrangement, as shown, but only to suggest the idea. For the bolt he would prefer to have the head under the tie, with a nut screwing down on the rail clip; while for the screw he thought it would be better to use a clip or washer, instead of having the broad head of the screw come directly on the rail flange. On the Belgian State Railways, the rails rest on iron sole-plates, which have a rib on each side, on which the outer side of the screw-head takes a bearing. With either of these types of fastenings there is a positive hold against the vertical pull of the rail, the head or nut of the bolt having a bearing against the bottom of the tie, and the thread of the screw being embedded in the wood; while with the spike the only resistance is that due to the friction between the wood and the iron.

The adoption of an efficient and secure fastening would tend greatly to reduce the trouble with the joints, as by holding the rail firmly to the ties the leverage at the joints is reduced, and a 4-bolt splice might be sufficient where now a 6-bolt splice, 40 or 44 ins. long, with an extra tie under the joint, is re-

quired. In England, 4 bolts are invariably used, often with plain straight splice bars, but sometimes with deep bars on lines with very heavy traffic. There is comparatively little trouble with these joints, owing to the rigid way in which the rails are secured to the chairs and the chairs to the ties.

A matter to which special attention was called was that of the use of metal ties instead of wooden ties, not only on account of the extensive extinction of forests to supply timber for ties for new lines and renewals, but also on account of the greater efficiency and durability of the track. In Europe, steel ties are in extensive use on main lines, light lines and street railways, and steel ties and cast-iron "bowls," arranged in pairs connected by tie-rods, are in use in India, South America, and other parts of the world. In Queensland (Australia) a very interesting type of track has been laid across the prairie country in the northern part of the colony, for a distance of about 36 miles. It consists of steel ties of channel section, bedded directly in the surface soil, which has been previously ploughed, and the soil is well tamped into and around the ties. The rails are secured by clips and bolts, and the top of the rail is only about 4½ or 5 ins. above the ground. The line is cheap in construction, and it has been suggested that such a system might be applicable to some of the prairie lines of this country.



Suggestions for Improved Rail Fastenings.

Experience in foreign countries seems to have shown that the best type of metal track consists of steel cross-ties of inverted trough section, with closed ends to prevent lateral movement, and with bolt fastenings for the rails. A special advantage claimed for such a system of track is its economy in maintenance; for when once the parts have been well settled, and the bolts screwed up after a few months' service, very little work is required to keep the track in safe and good condition. The writer has been investigating the use of metal track on railways in foreign countries, and has been surprised at the great extent to which it is adopted. A report on this subject has been made to the Department of Agriculture and will be published shortly.

With regard to the adoption of standard rail sections, fastenings, joints, etc., by the Association it is very desirable to carry out investigations as to the merits of different designs and plans, as such investigations will not only lead to the recommendation of improvements, but also to the showing up of minor errors and bad practices and the making of minor improvements, all of which will tend to elevate the condition of the track to the desired standard. In order to avoid conflicting standards or recommendations, the Association and its committees should act in conjunction with other Associations and their committees which are working on the same lines.

In conclusion it was suggested that the Committee on Roadway, or other committees, be directed to consider and report upon the following matters:

1. The merits of different forms of rail sections, and the adoption of standard sections from 50 to 110 lbs. per yd.; with a recommendation for the introduction of heavy rails.

2. The merits of different methods of securing rails to ties, and the recommendation of some method as an improvement on the now universal method of spiking, especially for heavy rails.

3. The merits of different rail-joint fastenings, and the recommendation of a standard joint fastening, with due consideration of the recommended standard tie fastening.

4. The question of the advantages of steel ties for main lines with heavy traffic, and for prairie lines, with the desirability of making any recommendations on this point. Also the consideration of the use of metal soleplates on wooden ties.

5. The equipment of railways with such safety appliances as the block system, complete systems of semaphore signals, interlocking apparatus, frogless and safety switches, rerailing guards, the use of various electric and automatic signals, etc.

With the rapid growth of the country, the railway system, and the railway traffic, it is evident that considerable improvements can be and should be made for the safe and efficient operation of the railways; and the consideration and recommendation of such improvements may be appropriately undertaken by the Association of North American Railroad Superintendents.

The Stuart Elastic Tie Plate.

The device illustrated is primarily designed for wooden ties, being claimed to be an advantage even for wood ties in respect to smooth and noiseless motion. But whatever advantages it may have with wood will of course be intensified with iron ties, and will reach their maximum with stone ties, if the plates prove sufficiently elastic to permit of the use of stone ties, as it is claimed they do. A practical test of the use of stone ties, in the form illustrated in the accompanying Fig. 4, has been made in Sweden on the Ystad-Eslof Railway, where, in the beginning of 1883, about 100 wood sleepers were exchanged for a corresponding number of longitudinal rock sleepers with elastic tie-plates as rail supporters. According to reports from the General Superintendent of this railway, the stones have laid perfectly still, and the track has not needed any adjustment whatever on the part of the road where the rock ties and tie plates have been in use. His exact words are: "The stones lie firmer and steadier than the wood ties. The tie plates have answered every purpose for which they are intended, their elasticity has not been lessened in any degree during the time they have been in use; they do considerably lessen the noise from the trains running over them, prevent the shaking of the cars, and make traveling more comfortable. It seems beyond doubt that in course of time the cost of rock sleepers with elastic tie plates will be considerably less than that of wood sleepers, wherever wood sleepers cost more than 40 cts. a piece."

On the Bergslegerna Railway in Sweden, the tie plates have been in use on wooden ties upon a few thousand feet of the track since the beginning of 1884, and the General Superintendent reports, in a letter dated Gothenburg, June 27, 1887, that "the elasticity of the plates has not been lessened in any degree, and that none of them have broken." Of course if their elasticity be sufficient and permanent, a rock tie or any other support, it matters not how hard, will answer perfectly well; and if rock ties could be made to answer, it is apparent that they would have an advantage in cost and durability over either wood or steel. There is of course no fair comparison between such use of stone and that which resulted so disastrously in the early days of railways from lack of elasticity in the support. If adequate elasticity can be supplied by some device like that illustrated, the whole objection to stone falls to the ground, and it becomes the best of all possible materials for "sleepers," as such blocks would then have to be called, since the term of "cross-tie" would be inapplicable to them, unless made long enough to cross the track like a wooden tie.

A comparison between the expense of steel ties and rock ties with the use of the elastic tie-plate is made by the company controlling the elastic tie-plate, as follows:

Cost of Rock-Tie Track per Mile.

2,080 stone ties delivered at 70 cts.	$1,456.00
4,160 steel plates 18 cts. each	748.80
8,320 bolts at 5 cts. each	416.00
640 iron rods at 25 cts. each	160.00
Total first cost	$2,780.80

Cost of Steel-Tie Track.

2,080 ties at $1.75	$3,640.00
4,160 steel plates at 18 cts. each	748.80
8,320 bolts at 2 cts.	166.40
Total first cost	$4,555.20

Wooden tie track will of course vary in cost within wide limits according to locality, but for the items covered above (ties and spikes only) will ordinarily run about $1,700, and has to be renewed complete every five to eight years, averaging say seven years. Of course, if stone blocks could be used (we have no opinion to express as to whether they can be, except to say that the only obstacle is lack of a sufficiently elastic bed for the rail) the sleepers become practically indestructible, at least, to a far greater extent than even steel ties; for there is nothing in experience with steel ties to date to warrant the belief that they will ever be serviceable for more than fifteen or twenty years, perhaps less.

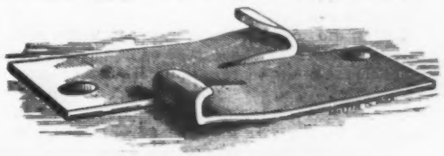


Fig. 1. Perspective View.

To see whether there is any economy in the possible use of stone blocks it is to be remembered that no wise railway manager makes a larger present expenditure to save expenses seven years or more ahead unless he sees the way to pretty good interest on his money, say 8 per cent. The present worth of $1.00 payable at future periods 7 years apart is:

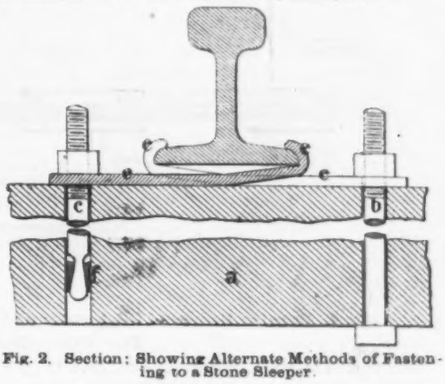


Fig. 2. Section; Showing Alternate Methods of Fastening to a Stone Sleeper.

						cts.	
Present worth of $1.00						100 0	
" "	7 years from date					58.4	
" "	14 "	"	"			34 0	
" "	21 "	"	"			19.9	
" "	28 "	"	"			11 6	223.9
" "	35 "	"	"			6 8	
" "	42 "	"	"			3 9	
" "	49 "	"	"			2.3	
" "	56 "	"	"			1.3	
" "	63 "	"	"			0 7	
" "	70 "	"	"			0.4	15.4
Total present worth of saving a $1.00 outlay every 7th year for 70 years						239.3	239.3

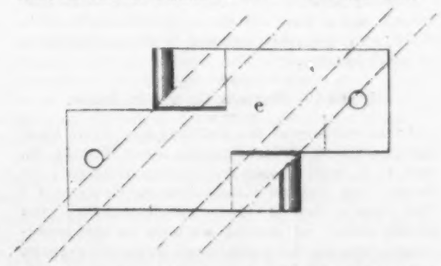


Fig. 3. Plan; Showing Manner of Applying and Removing Plate from Rail.

It will be seen from this table how very little present difference it makes whether a tie or rail will last 28 years, or 70 years, or forever. As compared with an article which lasts 7 years, the respective values are, with 8 per cent. interest:

Lasting 7 years.	28 years.	70 years.	Forever.
Value, $1.00	$2.24	$2.39	$2.41

If, therefore, we take wooden ties as costing with spike $1,700 per mile, it is admissible to spend at least double this for ties which will last 28 years or more, or $3,400; and all of this sum, over about $1,456 for the stone sleepers proper, might be devoted to elastic plates to carry the rails over them, if feasible at all, or charged up as profit.

We think there are chances in this direction

worth some experiment, and should much like to see them made with this or some equivalent elastic device, as it cannot be regarded as by any means demonstrated that this may not prove the best form of superstructure, at least for yards and such special uses.

The alternate methods used for fastening these tie-plates to stone blocks or rock are shown in Fig. 2. When it is a mere stone block or sleeper, the form *b* is used. When it is inconvenient or impossible to use a headed bolt, the form *c* is used, wedges fitting into recesses in the bolt and holding it firmly when the nut is screwed up. By loosening the nut, however, the bolt can at any time be dropped down.

The elastic tie-plate, however, is not introduced primarily for use on either stone or iron ties, or its probable use would be very limited, but for use on wooden ties. The advantages claimed are, protection of the wood from abrasion and cutting, as with any other tie-plate, decreased chance of breakage of rails in cold weather, decreased noise, deemed especially important for elevated lines, and especially decreased disturbance of the bed of the tie.

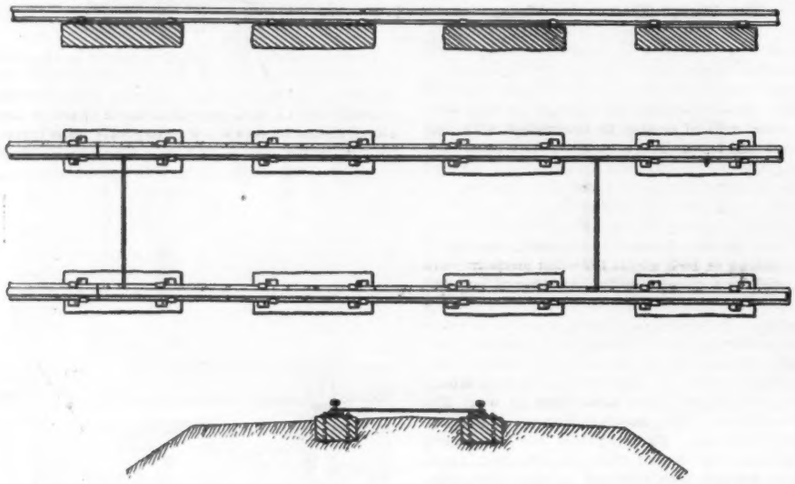


Fig. 4. Showing Manner of Using Plates with Stone Sleeper, Ystad-Eslof Railway, Sweden.

The Stuart Elastic Tie Plate.

The tie-plate can be exchanged if necessary, without removing tie or rail, by twisting it to an angle of 45° under the rail, as shown in Fig. 3. Their size, out to out, is 5½ by 7¾ ins., and thickness ¼ to ⅜ in. They weigh about 3½ lbs. each. It may look as if the plates would tend to break or bend in the center, but this is said not to be the case if they are properly bolted down. In any case, it is a mere question of proportion to avoid this danger.

Further information in regard to these plates may be obtained of Mr. C. M. STUART, 31 Broad St., New York, who invented them and is introducing them into this country.

Broad vs. Narrow Gauge in India.

At the meeting of the Institution of Civil Engineers on March 12, Mr. FRANCIS JOHN WARING, M. Inst. C. E., read a paper on "Indian Railways: the Broad and Narrow Gauge System Contrasted." The author showed that, notwithstanding the higher outlay of capital per mile on the broad-gauge than on the metre-gauge lines, the average net returns were higher upon the broad-gauge railways. This was due, not only to the total earnings per mile being higher, but also to the fact that the working expenses did not increase in the same proportion per mile per week and per train mile. The cost per 1,000 gross ton miles moved was more than 50 per cent. higher upon the railways of the metre gauge, upon which the percentage of working expenses was 12½ per cent. higher than upon the broad gauge. The coaching receipts per train mile were in favor of lines of the broad gauge to the extent of nearly 10 per cent.; but the percentage of freight to dead weight was 2.13 per cent. in favor of the metre gauge railways. A similar examination into the statistics of the goods traffic showed greatly increased economy in the working of the broad-gauge lines. The proportion of paying freight upon the capacity hauled was in their favor, while the proportion of freight-weight to dead-weight was practically the same upon railways of both gauges.

With respect to the percentages of earnings from various sources to the total earnings, the railways of 5 ft. 6 ins. gauge had secured a larger proportion of goods traffic, on which the profits seemed to be higher than on passenger traffic. The cost of maintenance per mile of line, per mile of track, and per train mile was higher upon the 5 ft. 6 ins. gauge, yet the excess was not even approximately in proportion to the excess in weight of the traffic passing over each mile, and to the increased weight of the trains, and the balance of economy was largely on the side of the broad-gauge railways. The author argued that the type of permanent way adopted for the metre-gauge lines was not so suitable as that adopted for the heavier traffic on the lines of 5 ft. 6 ins. gauge; and that an increase in the weight of the rails, in the scantlings of the sleepers, and in the amount of ballast used on lines of the narrow gauge, would be attended with beneficial results. The author then discussed the cost and particulars of locomotive expenses, and showed that the average expenses per 1,000 gross ton-miles were nearly 28 per cent. in favor of the broad-gauge lines. On the other hand, carriage and wagon expenses were less on metre gauge lines, as were also, to some extent, traffic expenses per train mile. Finally, the average amount of general charges per train mile was much higher upon railways of the metre gauge than upon those of the 5 ft. 6 ins. gauge.

Tables for Power of Compound Pumping Engines.

BY JOHN W. HILL, M. E.

For the purpose of simplifying and facilitating the calculations required in proportioning non-receiver compound rotative and direct acting pumping engines to the work required in any given situation, the following tables were prepared.

Having the quantity of water to be delivered per day of 24 hours and the type of engine (rotative or direct acting) fixed, the dimensions of pump are easily determined as for resistance.

Five million gallons per diem., with a rotative engine operating at 150 ft. piston speed per minute, estimated loss of action taken at 4 per cent. of plunger displacement.

$$\frac{5{,}000{,}000}{24 \times 60} = 3472.2 \text{ galls. per diem.}$$

Capacity of pump per minute.

$$\frac{3472.2}{.96} = 3616.87 \text{ galls. per min.}$$

With a duplex arrangement of pumps, each pump will have a capacity of

$$\frac{3616.87}{2} = 1808.435 \text{ galls.}$$

or

$$\frac{1808.435}{150} = 12.0562 \text{ galls. per foot of travel.}$$

And proper area of plunger.

$$\frac{12.0562 \times 231}{12} = 232.081 \text{ sq. ins.}$$

equivalent to a diameter of

$$\sqrt{\frac{232.081}{0.7854}} = 17.19 \text{ ins.}$$

or for convenience say 17.25 ins. If such plunger had a stroke of 3 ft., the revolutions of engines would be 25 per minute.

Assume this 5,000,000 galls. is delivered against a head including friction of 277 ft., or 120 lbs. in round numbers, then the moment of water load is

$$17.25^2 \times 0.7854 \times 120 = 28045.2 \text{ lbs.}$$

and the moment of steam end of engine to easily overcome this load, including friction of engine, should be

$$\frac{28045.2}{0.85} = 32994.35 \text{ lbs.}$$

The usual proportion of low-pressure to high-pressure cylinders in two-cylinder compound rotative pumping engines is 4 to 1. Now, having deduced the moment of work for the steam piston, the inquiry that follows is, What shall be the steam-pressure, point of cut-off or grade of expansion and diameters of steam cylinders?

The steam pressure is usually arbitrated, and for purpose of illustration may be taken at 100 lbs. by gauge. If the engine is to work for high duty, the number of expansions would be taken at 14-16 or the cut-off in the high-pressure cylinder fixed at ¼-stroke of piston.

Referring to the subjoined table for an absolute pressure of 115 lbs. (100 lbs. by gauge) and a cut-off in the first cylinder of ¼-stroke, the mean effective pressure (upon the assumption that the steam is cut-off and expanded and the entire work done in the second or low-pressure cylinder, is 24.86 lbs. (engine worked condensing) and area of L. P. piston for the case of 5,000,000 galls. per day against 120 lbs. total head or pressure.

$$\frac{32{,}994.35}{24.80} = 1{,}330.4 \text{ sq. ins.}$$

or say 41.25 ins. diameter.

The usual proportion of steam cylinders adopted for such a case would be 21 H. P. and 42 L. P., which, as the illustration shows, are ample for the quantity of water and head taken in the example.

It sometimes happens in water-works practice that it is desirable to take an engine pumping in low service and adapt it to high service or the reverse. In this case the dimensions of steam cylinders are fixed, and generally the boiler pressure known.

For given steam pressure and desired point of cut-off, take from the table the mean effective pressure, and multiply the area of L. P. piston by this; the product will be the moment of work for both steam pistons; for example,

Let the diameter of H. P. piston be		18 ins.
"	diameter of L. P. " "	36 "
"	steam pressure	80 lbs.
"	expansion	12 "

The nearest tabled cut-off is ⅛ for this number of expansions, and mean effective pressure (always upon the assumption that the steam is admitted, cut-off, and expanded in the L. P. cylinder, or that to the actual mean effective pressure in the second cylinder is added the corresponding mean effective pressure in the first cylinder, reduced in inverse proportion of cylinder areas) for 95 lbs. absolute (80 by gauge) 23.017 lbs.

This into the area of L. P. piston reduced in proportion of 8.5 to 10 gives the moment of water load,

$$23.017 \times 1017.9 \times .85 = 19914.65 \text{ lbs.}$$

The head to be pumped against will be taken as equivalent to 90 lbs., then area of pump plunger,

$$\frac{19914.65}{90} = 221.27 \text{ sq. ins.}$$

corresponding to a diameter of 17.00 ins. nearly, and two such pumps double acting at 150 ft. piston speed will discharge 4,767,017.8 galls. per day with an allowance of 4 per cent. for loss of action.

The tables for crank and fly wheel engines are calculated for the following proportions of steam and of pumping engines:

High-pressure cylinder,	area	...	1.000
" " "	clearance	...	0.025
Low " "	area	...	4.000
" " "	clearance	...	0.100

Woolf style, intermediate space represented by the clearance of low-pressure cylinder.

Counter-pressure, absolute, 3.00 lbs.

Table A contains the data upon which the following tables of mean effective pressures are calculated, column 1 giving the decimal of stroke of high-pressure piston to point of cut-off, from $\frac{1}{10}$ by $\frac{5}{100}$ to full stroke.

TABLE A.—EXPANSION FOR DIFFERENT POINTS OF CUT-OFF. WOOLF COMPOUND ENGINE.

Clearance taken 2½% Piston Displacement. Cylinders, Diameter 1 to 2.

Cut-off, H. P. cyl.	Expansion H. P. cyl.	Expansion L. P. cyl.	Expansion L. P. clearance.	Total expansion.	Effective expansion.	Hyp. logarithm.	Reciprocal total expansion.
0.10	8.200	3.666	1.09756	32.994	30.061	3.4032	0.0303
0.15	5.857	3.666	1.09756	23.566	21.472	3.0667	0.0424
0.20	4.555	3.666	1.09756	18.330	16.698	2.8153	0.0545
0.25	3.727	3.666	1.09756	14.996	13.663	2.6147	0.0666
0.30	3.154	3.666	1.09756	12.691	11.562	2.4477	0.0788
0.35	2.733	3.666	1.09756	10.996	10.019	2.3045	0.0909
0.40	2.412	3.666	1.09756	9.705	8.842	2.1795	0.1030
0.45	2.158	3.666	1.09756	8.683	7.911	2.0682	0.1151
0.50	1.952	3.666	1.09756	7.854	7.156	1.9679	0.1273
0.55	1.783	3.666	1.09756	7.174	6.536	1.8773	0.1395
0.60	1.640	3.666	1.09756	6.598	6.012	1.7937	0.1515
0.65	1.519	3.666	1.09756	6.112	5.568	1.7170	0.1636
0.70	1.414	3.666	1.09756	5.689	5.183	1.6454	0.1758
0.75	1.323	3.666	1.09756	5.323	4.850	1.5789	0.1876
0.80	1.242	3.666	1.09756	4.997	4.553	1.5158	0.2001
0.85	1.171	3.666	1.09756	4.712	4.293	1.4569	0.2122
0.90	1.108	3.666	1.09756	4.458	4.062	1.4017	0.2243
1.00	1.000	3.666	1.09756	4.023	3.666	1.2991	0.2485

Column 2 gives the expansion of steam in the high-pressure cylinder for the corresponding point of cut-off.

Column 3 gives the constant expansion in the low-pressure cylinder.

Column 4 the constant expansion in the intermediate void or L. P. cylinder clearance space.

Column 5 the total expansion.

Column 6, the effective expansion.

Column 7, hyperbolic logarithm of effective expansion, and

Column 8, reciprocal of total expansions, from which, and the pressure at cut-off in the H. P. cylinder, the terminal pressure is deduced.

For small variations in the proportions of cylinders and in the clearances, the constants given can be used for fair approximations.

Table *B* contains the mean effective pressures for the points of cut-off in high-pressure cylinder given across the head of table, and the absolute pressures (at cut-off) given in the first column. The constants under the points of cut-off respectively are deduced as follows:

Let L = decimal of stroke H. P. piston to point of cut-off.

l = clearances of H. P. cylinder expressed in decimal of stroke.

r = ratio L. P. to H. P. cylinders.

h = hyperbolic logarithm of effective expansion, and

x = constant for given point of cut-off; then,

$$x = \frac{[(L+l)\times h]-l}{r} \quad \text{or} \quad h = \frac{L+l}{r} - \frac{l}{r}$$

This constant, multiplied by the absolute pressure of steam at cut-off, less assumed counter pressure of 3 lbs., gives the corresponding mean effective pressures.

Table *C* contains the general data for the steam ends of four proportions or classes of compound, duplex, direct-acting pumping engines, thus

Class *A* embraces engines where the diameter of L. P. piston is 1.5 times the diameter of H. P. piston, as 8 and 12, 12 and 18, 16 and 24, etc.

Class *B* embraces engines where diameter of L. P. piston is 1.6 times the diameter of H. P. piston as 10 and 16, 15 and 24, etc.

Class *C* embraces engines where the diameter of 2 L. P. piston is 1.57 times the diameter of H. P. piston, as 14 and 22, 21 and 33, etc.

Class *D* embraces engines where the diameter of L. P. piston is two times the diameter of H. P. piston, as 12 and 24, 16 and 32, 18 and 36, etc.

The table contains the piston displacements, clearances and expansions, based upon volume (1) and expansion (1) in high-pressure cylinders. The hyperbolic logarithms for the effective expansions and the reciprocals of total expansion.

Table *D* is calculated for compound duplex direct-acting pumping engines, when worked *condensing*,

TABLE C.—COMPOUND DUPLEX DIRECT ACTING ENGINES.

Cylinder Volumes and Clearances stated in terms of H. P. Cylinders and Steam Full Stroke, H. P. Cylinder.

Terms	Class of Engine A	B	C	D
Diam. C. P. cyl. (H. P. = 1.00)	1.5	1.6	1.57	2.0
H. P. cylinder, area	1.000	1.000	1.000	1.000
" " clearancer	0.0630	0.0630	0.0630	0.0600
Intermediate space	0.3388	0.3388	0.3388	1.1200
L. P. cylinder, area	2.2500	2.5600	2.4700	4.0000
" " clearancer	0.1135	0.1280	0.1235	0.2040
Expansion H. P. cyl.	1.0000	1.000	1.0000	1.0000
" intermediate	1.3190	1.4391	1.4350	2.2500
—— space	1.8254	2.0200	1.9840	2.2584
Expansion L. P. cyl.	2.6000	2.9067	2.8182	5.0814
Total expansion	1.8254	2.0200	1.9840	2.2584
Effective "	0.6018	0.7031	0.6750	0.8146
Hyperbolic Log	0.3846	0.3440	0.3548	0.1968
Reciprocal total expansion				

diameter, and the steam pressure is 70 lbs. What size or diameter of pump will this work against a pressure or head of 80 lbs. (184.64 ft.)?

The data will be found in class *A*.

The area of the L. P. piston (24 ins. diameter) is 452.39 sq. ins., and mean effective pressure for absolute pressure of 85 lbs. (70 by gauge) is 58.438, and moment of water load:

$$452.39 \times 58.438 \times .85 = 22471.24 \text{ lbs.}$$

TABLE. E.—MEAN EFFECTIVE PRESSURE, ENGINE WORKED NON-CONDENSING.

Compound Duplex Direct Acting Pumping Engine. Steam full stroke H. P. cylinder; Counter-pressure 17 lbs. abs.

Initial Pressure Absolute	Class of Engine A.	B.	C.	D.
	Constants.			
	0.72869	0.68252	0.69542	0.46587
65	30.364	27.364	28.202	13.281
70	34.068	30.777	31.679	15.611
75	37.652	34.189	35.156	17.940
80	41.295	37.602	38.633	20.269
85	44.938	41.015	42.111	22.599
90	48.582	44.427	45.588	24.925
95	52.225	47.840	49.065	27.159
100	55.869	51.253	52.542	29.587
105	59.512	54.665	56.019	31.978
110	63.156	57.078	59.496	34.248
115	66.799	61.490	62.973	36.577
120	70.443	64.903	66.450	38.907
125	74.086	68.316	69.927	41.236
130	77.729	71.728	73.404	43.563
135	81.373	75.141	76.881	45.892

The head is 80 lbs., and area of plunger which a steam end containing high-pressure piston 16 ins. diameter, and low-pressure piston 24 ins. diameter, with steam pressure of 70 lbs. well drivers:

$$\frac{22,471.24}{80} = 280.89 \text{ sq. ins.}$$

corresponding to a diameter of 19.0 ins. nearly.

TABLE B.—MEAN EFFECTIVE PRESSURES, WOOLF COMPOUND ENGINES.

H. P. cylinder = 1. L. P. cylinder = 4. Clearance H. P. cylinder = 0.025, L. P. cylinder = 0.10. Intermediate space = 0.0 and Counter Pressure 3 lbs., abs.

Initial Press're Abs'lute	Points of Cut-off, High Pressure Cylinder. 0.10	0.15	0.20	0.25	0.30	0.35	0.40	0.45	0.50	0.55	0.60	0.65	Points of Cut-off, H. P. Cylinder. 0.70	0.75	0.80	0.85	0.90	1.00
	Constants. 0.13135	0.17166	0.20836	0.24226	0.27387	0.30354	0.33157	0.35809	0.38322	0.40736	0.43026	0.45224	0.47322	0.49341	0.51263	0.53119	0.54914	0.58289
60	4.881	7.299	9.501	11.535	13.432	15.212	16.894	18.485	19.997	21.441	22.815	24.134	25.393	26.605	27.758	28.871	29.948	31.973
65	5.538	8.158	10.543	12.747	14.801	16.730	18.552	20.276	21.973	23.478	24.967	26.395	27.759	29.072	30.321	31.527	32.694	34.888
70	6.194	9.016	11.585	13.958	16.171	18.248	20.210	22.066	23.829	25.515	27.118	28.657	30.125	31.539	32.884	34.183	35.440	37.802
75	6.852	9.874	12.627	15.169	17.540	19.765	21.868	23.856	25.740	27.552	29.269	30.918	32.491	34.006	35.447	36.839	38.185	40.717
80	7.509	10.733	13.669	16.381	18.909	21.283	23.525	25.647	27.662	29.589	31.421	33.179	34.857	36.473	38.010	39.495	40.931	43.631
85	8.166	11.591	14.711	17.592	20.279	22.801	25.183	27.437	29.579	31.626	33.572	35.440	37.224	38.940	40.573	42.151	43.677	46.545
90	8.822	12.449	15.752	18.803	21.648	24.319	26.841	29.228	31.495	33.662	35.723	37.701	39.590	41.407	43.137	44.807	46.423	49.460
95	9.480	13.308	16.794	20.015	23.017	25.836	28.499	31.018	33.411	35.699	37.875	39.963	41.956	43.874	45.699	47.463	49.168	52.374
100	10.137	14.166	17.836	21.226	24.387	27.354	30.157	32.809	35.328	37.736	40.026	42.224	44.322	46.341	48.263	50.119	51.914	55.289
105	10.794	15.024	18.878	22.457	25.756	28.872	31.815	34.599	37.244	39.773	42.177	44.485	46.688	48.808	50.826	52.775	54.660	58.203
110	11.450	15.883	19.920	23.648	27.126	30.389	33.473	36.390	39.161	41.809	44.328	46.746	49.054	51.275	53.389	55.431	57.405	61.118
115	12.107	16.741	20.961	24.860	28.495	31.907	35.130	38.180	41.077	43.846	46.480	49.007	51.420	53.742	55.952	58.087	60.151	64.032
120	12.764	17.599	22.003	26.071	29.864	33.425	36.788	39.971	42.993	45.883	48.631	51.269	53.786	56.209	58.515	60.743	62.897	66.947
125	13.421	18.457	23.045	27.282	31.234	34.942	38.446	41.761	44.910	47.920	50.782	53.531	56.152	58.676	61.079	63.399	65.642	69.861

and gives for each of the four classes the mean effective pressure reduced to work of L. P. piston for the absolute pressure of column 1, for example:

TABLE D.—MEAN EFFECTIVE PRESSURES, ENGINE WORKED CONDENSING.

Compound Duplex Direct Acting Pumping Engines; Steam Full Stroke; H. P. Cylinders, Counter Pressure, 3.5 lbs. abs.

Initial Pressure Absolute	Class of Engine A	B	C	D
	Constants			
	0.72869	0.68252	0.69542	0.46587
65	43.804	40.864	41.702	26.781
70	47.508	44.277	45.079	29.111
75	51.152	47.689	48.656	31.440
80	54.795	51.102	52.133	33.769
85	58.438	54.515	55.611	36.098
90	62.082	57.927	59.088	38.428
95	65.725	61.340	62.565	40.059
100	69.369	64.753	66.042	43.087
105	73.012	68.165	69.519	45.418
110	76.656	71.578	72.996	47.746
115	80.299	74.990	76.473	50.077
120	83.943	78.403	79.950	52.407
125	87.586	81.816	83.427	54.736
130	91.229	85.228	86.904	57.063
135	94.873	88.641	90.382	59.392

The steam end of a compound, duplex, direct-acting, condensing engine has cylinders 16 and 24 ins. Two such pumps, double-acting, will deliver at 100 ft. piston speed per minute 4,084,309.9 galls. per day of 24 hours.

Table *E* contains the mean effective pressures for compound, duplex, direct-acting, pumping engines, worked *non-condensing*.

The table of mean effective pressures is applicable only to the Woolf or non-receiver type of engine, and assumes that the steam is admitted directly to, and the entire work performed in the second or L. P. cylinder.

The ratios of expansion have been calculated as follows:

Let a = volume of H. P. cylinder swept through by piston = 1.

c = clearance in decimal of stroke of H. P. piston.

$4a$ = volume of L. P. cylinder swept through by piston = 4.

$4c$ = clearance of L. P. cylinder.

x = point of cut-off in decimal of stroke H. P. piston.

D = stroke of both pistons taken as unity.

then $E = \dfrac{a+c}{x+c} = \dfrac{1+c}{x+c}$

$$E_1 = \frac{a+c+4c}{a+c} = \frac{1+5c}{a+c}$$

$$E_2 = \frac{4a+4c+c}{a+c+4c} = \frac{4+5c}{1+5c}$$

$E_3 = E, E_2.$

$E_4 = E, E_1 E_2.$

Where E — expansion in H. P. cylinder.

E_1 — expansion in intermediate space or in the combined clearances of both cylinders.

E_2 — expansion in L. P. cylinder,

E_3 — effective expansion, and

E_4 — total expansion.

For a given volume $(x + c)$ of steam cut-off in H. P. cylinder, it is assumed the corresponding volume cut-off in L. P. cylinder will be represented by $\frac{x}{4} + \frac{c}{4} - \frac{x+c}{4}$, and the total effective work for 1 sq. in. of H. P. piston, and 1 ft. of stroke, per pound total or absolute pressure,

$$H = (Hyp.\ Log.\ of\ E_2 + 1)\left(\frac{x+c}{4}\right)$$

∴ if p — absolute pressure and p_1 — average back pressure, then $(W\ p) - p$ — average mean effective pressure per square inch of L. P. piston, for the work of both pistons combined.

Changing the Color of Blue-Print

The conversion of blue ferro-prussiate photographic prints is now accomplished, according to *La Nature*, by taking the positive blue-print, when thoroughly washed and dried, and plunging it into a solution of ammonia, in which it is kept until it has nearly or entirely lost its color, which operation lasts from two to four minutes. The print is rinsed and plunged into a bath of tannic acid, this continuing until the desired sharpness and tone have been obtained. The last operation requires a bath of about twelve hours, and if, at the end of such length of time, the color be not dark enough, it is intensified by adding to the bath a few drops of ammonia; after a lapse of one or two minutes, the prints are rinsed in an abundance of water. By means of this treatment they are made to present a beautiful appearance, resembling, especially in color, sepia drawings.

To impart a black tone to prints made by the ferro-prussiate process, they are plunged into a solution of four parts of potash in one hundred parts of water, then, when the blue color has entirely disappeared under the action of the potash, and a yellowish color has taken place, they are immersed in a solution of four parts of tannin, also in one hundred parts of water. On again washing, prints are obtained whose tone may be assimilated to that of pale writing ink.

A Drifting Test for Steel Angle Bars.

The cut herewith illustrates a drifting test of the toughness of medium steel for structural purposes recently devised by Messrs. Hunt & Clapp, of the Pittsburg Testing Laboratory, as a supplement to other tests, and found to be one of the most effective of them all. The cut we have had prepared from an actual specimen sent us by Messrs. Hunt & Clapp, and it is as faithful as our artist can make it. The metal is throughout absolutely without a sign of crack or outward blemish.

The angle illustrated is a piece of 6 x 4 x ⅝-in. angle, which tested as follows in an Olsen machine:

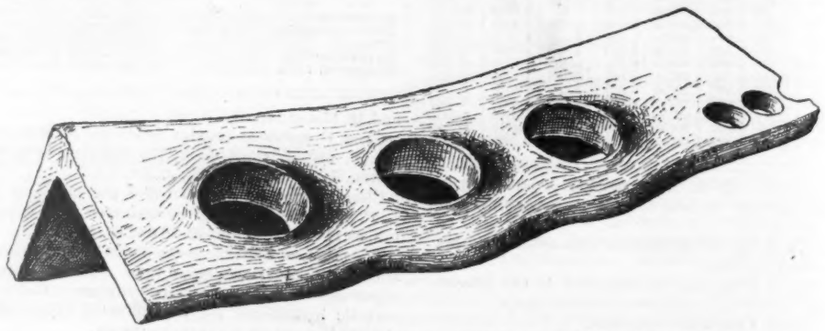
Ultimate strength	61,810 lbs.
Elastic limit	36,779 "
Elongation in 8 ins.	28.25 per cent.
Reduction of area	56.73 "

The large holes shown were originally ⅞-in. punched holes, of the size of the small holes which show in the cut, punched 2 ins. from edge of angle, and 3 ins. between centres. The angle so punched was then placed on a blacksmith's anvil and the holes enlarged to their present size by the blows of a sledge on a drift pin. The holes now average 1¾ ins. in diameter, with edges perfectly sound throughout, and the flow of the metal is graphically shown.

This test is an inexpensive one, and in Messrs. Hunt & Clapp's opinion, is a very satisfactory one. They now use it regularly on all steel which is to be riveted up without reaming, and also in other cases where they wish to demonstrate the qualities of individual bars.

A cropping answers very well for such a test, and it is found that material which is "short" or burned, or which is too hard chemically, will fail under such treatment. This particular specimen was made at the Pencoyd Iron Works, and is a sample of a batch of angles which will go into the new Hawk Street Viaduct in Albany, N. Y., of which Prof. PALMER C. RICKETTS is the engineer. The specifications used for this material are Cooper's specifications for medium steel.

This test is precisely in the line of a too limited list of others, which substitute a test somewhat approximating the actual destructive strains of service for the bare tension and compression tests, which are all right for the members or parts of members exposed to like strains in service, but which give no absolute indication of how the metal will behave under other than tensile and compressive strains. Rails, for example, are now bought and sold absolutely without an effective test for their real wearing qualities. We have often stated, and now repeat, that the real tests which it is desirable to establish for rails are, first, a wearing test under abrasion; secondly, a deformation test under impacts of heavy loads at very low velocities; thirdly (and this is the only test for rails now practised which sheds any real light on their quality) breaking tests under impact. All chemical and mechanical tests other than this merely serve the negative use of excluding exceedingly bad rails. They do not show whether a rail of fairly good metal will wear well or ill in service, but rather, often indicate directly wrong conclusions.



Drifting Test for Steel Angle-Bars; Pittsburg Testing Laboratory.

Another test of this practical nature, which we may mention for illustration, is Mr. F. M. WILDER'S bending test for stay-bolt iron. Finding the ordinary tests gave no direct evidence whether stay-bolt iron would prove good or bad, and reasoning that stay-bolt fractures resulted from bending due to expansion and contraction until the bolt was broken off, as one might break a piece of wire in his fingers, it occurred to Mr. WILDER to imitate these strains exactly. A piece to be tested, 2½ to 3 ft. long, was fixed in a vice, and a piece of pipe slipped over it to give a grip, leaving about *six inches* bare next to the vice. Two men then walked around with the end of the pipe until the test piece was bent to a right angle, when they walked back again, and bent it to a right angle the other way. The quality was judged by the number of complete right-angle bends which it was possible to form without fracture, which varied from 4 to 16 in ⅜-in. iron sold as good stay-bolt metal, although the same lot would vary only two or three bends. A stipulation that all metal accepted must stand 12 bends resulted in a very speedy improvement in the quality of the metal, and gave the manufacturers a definite criterion, which greatly aided them also by enabling them to determine just what was necessary to fill the requirements. Until *consumers* determine such standards as this, it is quite idle to expect manufacturers to fulfil their expectations. They do not know how to do so, in the first place; and as the consumer will not give them credit for it, in the second place, for lack of a standard of comparison, but will probably buy some other iron ⅛ ct. per lb. cheaper, why should they take the trouble?

We welcome all simple, straightforward tests like these, believing them the most truly scientific and effective, and commend the one we now illustrate to the attention of our readers.

The Use of Liquid and Gaseous Fuels.*

I preface this paper by saying that this subject was assigned to me, I presume, because I betrayed an interest in it at our last meeting as an inquirer, and not because of any technical knowledge I possess concerning it. It has never been a habit of my life to shirk a duty. In performance of the duty in hand, I can only offer you the result of the work of an editor or compiler of information and opinions kindly placed at my service by friends, and gathered otherwise, and here bound into a rough fagot, which if your patience serves, you may take a part, if it so please you.

In the announcement of this topic, the first thought of the hearer or reader turns naturally to petroleum, and it is almost of necessity that this paper should most largely deal with it as the most prominent of gaseous or liquid fuels.

What is petroleum? The scientists cannot agree upon an exhaustive descriptive reply. It is a natural hydrocarbon oil, and perhaps as near an analysis as is possible may be:

Carbon, 84; hydrogen, 14; oxygen, 2.

Popularly speaking, it has been in use, one way and another, for about forty years. About that time has elapsed since scientific men first considered and studied the character of a dark, oily fluid which trickled from some seams in an English coal mine. In the intervening time it has been utilized in chemistry and the arts to an extent almost beyond belief, and demanding a constantly increasing scientific nomenclature as its uses have been adapted or expounded.

The abundance of its supply has, within the past 20 years, led to efforts for its successful use as a fuel, but the original methods have not been materially improved upon.

The romance of the story of coal and of petroleum (if we choose to consider the two as of close kin) is exceedingly attractive, and one which I would like to follow. My assigned subject, however, instructs me to speak only in a utilitarian way, and vulgarly and practically to consider fuels.

At the last meeting of this Association, held in Cleveland, O., two water departments reported experiments with crude oil. Mr. GERECKE, of Chicago, while not prepared with details, reported adversely, and in favor of coal. His later detailed report, as printed in Proceedings, confirms the statements he made from memory on the 6 months' experiment in the use of oil in the Chicago Water Department. He says, however, that the possible saving of labor and in repairs by the use of oil do not enter into his statement.

The other Water Department to which I have alluded is that of Cleveland, O. Mr. WHITELAW, Superintendent of that City Department, reported at our last meeting an extraordinary evaporation by oil fuel, which has been quoted and widely circulated by the Standard Oil Co. I have asked Mr. WHITELAW for the comparison *in dollars and cents* between the results of coal and oil fuel. He reports as follows:

The following calculations show the relative value of coal and petroleum as fuel for making steam as determined with oil at the water-works pumping station on Division St., beginning at 1.45 P. M., Sept. 30, and terminating at 7.45 P. M., Oct. 2, being 54 hours, or 2¼ days.

COAL FUEL.

Coal consumed: Average for 1886, 3,000 lbs. per million gallons 33¾ tons (of 2,000) at $1.35	$45 56
Labor, one fireman 54 hours at 23 cts.	12 42
Coal wheelers, 2¼ days at $1.66⅔	3.75
Hauling ashes, 1 day	2.75
Costing of pumping 22½ million gallons	$64.48

OIL FUEL.

Oil consumed, 6,131 galls. at 1¼ cts.	76.64
Labor, 1 man, half 54 hours—27 hours at 18½ cts.	4.95
Cost of pumping 22½ million gallons	$81.58

* Read by L. H. GARDNER, of New Orleans, La., at the Louisville Meeting of the American Water-Works Association.

Difference in 24 hours or 2¼ days	$17.11
Difference per day	7.60
Difference one year one battery of boilers	$2,774.00
Difference per million gallons	75 cts.
Difference one year pumping 20 million gallons per day	$5,475.00

In this connection it is to be remembered that Chicago and Cleveland enjoy unusual advantages in the matter of practical proximity to both coal and oil fields.

It is claimed by the friends of crude oil that 3 bbls. of 42 galls. each, equal and slightly exceed the heating capacity of one ton of good coal. This claim is confirmed by several large manufacturing establishments. This conceded, the average steam user has only to consult his local coal market to determine comparative economy. In adopting crude oil, he may, under average conditions, in the light of the reports I have read, gain a saving of the labor of firemen or stokers. I cannot go so far as to include cleanliness; for I have not seen nor have I heard of a fire-room where oil is used, that is either clean or sweet smelling. On the contrary, waste oil is everywhere about such furnaces, and the neighborhood is perfumed from early morn to dewy eve, and until morning comes again, not only with this, but with the language of denunciation in the vicinity, which hath a sulphurous flavor and which doth not savor of piety.

While upon the subject of smell, let me say that some claim it is due to leakage in the storage tanks or in conveying pipes. Others claim it is due to imperfect combustion. I incline to the latter view, although the London Warehouse Co. reports a heavy percentage of loss by evaporation through the wood of the barrels. Perfect combustion is not dependent upon any special form of burner, or to atomizing by steam or by air. But the air and steam systems each have their advocates and supporters, and oppose each other. This desirable perfect combustion is dependent upon physical laws in supplying the elements requisite for the purpose, and is a subject now occupying the attention of many students and inventors. It is admitted that the appliances now in use for burning oil have not, to say the least, reached the limit of perfection, and that, under equal conditions, it cannot everywhere compete with coal. Unfettered by "Trusts," it might perhaps do so.

I have visited many water-works plants and large manufactories during the last few years, and have been struck by the careless handling of coal to the furnace; i.e., the reckless firing and waste of fuel. Now, under such circumstances, any attempt at improvement or economy, whether in furnaces or in grate bars, or in change of fuel, is hedged about with a carefulness in trial which did not characterize the pre-existing conditions or practice. That carefulness goes always to the credit of the new system.

My own judgment is that good coal, handled by trained firemen held responsible under proper rules, with the checks of an automatic pressure gauge, of the automatic register of a boiler feeder, and accurate measurement of coal in the boilers,—in other words, with a good system of record and a trusty engineer to keep the record,—is demonstrably, in water-works practice, quite as economical a fuel as petroleum under existing conditions of competition.

I do not find that oil is anywhere used as a fuel simply for economy. I think I can discover special reasons why oil should be used under some circumstances rather than coal, even at superior cost. An extensive correspondence on the subject develops to my satisfaction that, as fuel for steam purposes only, the economies are liberally stated in relative cost of the fuel and labor. Otherwise stated, oil may be preferable where intensity of heat and the entirely steady maintenance thereof, subject to quick control, is desirable.

This can be automatically achieved by the use of oil and it is therefore commended to electric light plants, gas works, iron and steel works, glass works, etc., very many of which establishments endorse the use of oil as preferable to coal. For instance, Maj. CASTLE, Superintendent of the Barber Asphalt Paving Co., with several large plants in the United States, finds an economy in the use of oil amounting to over 30 per cent. over coal. This economy is incidental to the character of the business. An accuracy in intensity and quick control of applied heat is essential, whether in treating the sand used or in the distillation of the crude asphalt. In using coal, fires often have to be drawn and furnace doors thrown open and often without relief-entailing labor, loss of fuel, and the ruin of valuable material. Of course, he finds oil a more economical fuel than coal.

At the late meeting of the National Association of Brickmakers, at Memphis, Tenn., Mr. S. P. CRAFTS read a paper from which I extract the following. After a comparison as between wood, coal, gas, and oil, and carefully considering them, he says:

> From this it seems that there is very little difference between the cost of coal and oil, unless some other consideration intervenes. You may keep your bricks at a dull red for any length of time, and fail to burn them hard; but if you can in a shorter time, with oil, get the requisite temperature, then do the work in less time and at a saving of fuel. It seems to me that in this shortening of time, and saving thereby, is the principal argument in favor of oil over coal.

MR. CRAFTS, in this paper, further says that he does not think the same argument or economy will hold good when the two fuels are compared in use under boilers.

Further to illustrate the difference between steam users and the other consumers alluded to and the relative economies, in a discussion on the subject last fall, in the Franklin Institute, it was stated that a certain Philadelphia manufacturer had enjoyed the free use of gasoline for generating steam from some petroleum factory. Later, the manufacturer was asked to pay for it. After consideration, he decided on grounds of economy to use coal at the market price, rather than pay anything at all for gasoline

In Pennsylvania, with oil at 30 cts. per bbl., it has been shown that it costs nearly 50 per cent. more to move a train of cars 100 miles by means of oil than when burning coal. Coal and oil are equally accessible, and at the lowest prices in that State, and the great Pennsylvania Railway still burns coal.

The attention now being given to the subject throughout the country is something wonderful. Hundreds of thousands of dollars have been spent by private parties in experiments, and patents are being continually applied for in this connection. Something like fifty burners are on the market, and with more to follow.

As to Safety.—It is claimed that the use of oil may be deemed entirely safe on land. Prominent insurance companies, however, are watching it jealously, and its delivery by gravity to the furnace is for the most part forbidden. In quarters of high authority, it is denied that any explosion or conflagration has ever resulted from its use. The most notable case, to the contrary, is the steamer *Julia* disaster at San Francisco, in the past year. She used oil for fuel. She was a large ferry-boat of 407 net tons, owned by the Southern Pacific R. R. Co., plying between South Vallejo and Vallejo Junction. The boat was shattered from end to end by the explosion; 34 persons were killed and 22 more or less seriously injured. Only 3 persons on board escaped serious injury and the financial loss was $250,000. The coroner's jury censured the U. S. Inspector for allowing the use of oil as fuel on vessels. This officer, H. S. LUBBOCK, reported to the U. S. Treasury Department that the disaster was caused by the explosion of gases, which had accumulated in the fire-box of one of the boilers. This report was followed by an order of the Treasury Department forbidding the use of petroleum as a fuel for large boilers on steam vessels.

As to Supply.—The limit of supply of oil is a question of some interest in this connection. This may be considered in the sense of the actual end of the possible. In this day of consolidated "Trusts," we never actually know what either may be. Outside the American fields, think, if you please, of a Russian well spouting 2,750,000 galls. a day to a height of 224 ft., and of the owner of the well, instead of being enriched, becoming bankrupt by reason of the damage suits of his neighbors. The oil king could not store his oil, but had to let it deluge and ruin the adjacent property. Three or four years ago the excess of American production over consumption had accumulated to the extent of 39,000,000 galls., stored in tanks. The surplus reduction is now being reduced by some 10,000 bbls. per day. The total yield is said to be something over 70,000 bbls. a day. In Russia the average flow in the Baku region is 88,000 galls. per day. With increasing railway facilities in Russia, it is possible that the Russian product will not only displace American oil in European markets, but even invade America in competition. It remains for American inventive genius to come to the aid of both producers and consumers by showing them, in the light of its present abundance, how oil may economically compete with coal as a fuel.

So far I have spoken of gaseous fuel only in connection with petroleum. Allusions to natural gas would not perhaps be strictly germane to the subject assigned me, first, because the field of its use is limited, and second because the duration of its supply, at least in a competitive sense, is in the minds of many scientists, problematical. Among these is the eminent authority of Mr. SELWYN TAYLOR, C. E., of Pittsburg. He favors me with the following:

> I would say the amount of gas produced within a radius of 40 miles of Pittsburg is to day not more than 60 per cent. of that produced two years ago, while the number of producing districts is one-third more, and the actual number of wells nearly twice as many. What I have said relates almost solely to our own district; but what is true of it will certainly apply to others. Our most eminent authority on such matters in Pennsylvania is, perhaps, Prof. J. P. LESLIE, State Geologist, who is firmly of opinion that the life of our natural gas supply is very limited.
>
> Crude petroleum is being used to a limited extent by the Pennsylvania R. R., as a fuel, but with what economic results I cannot say. It has been used on only a few locomotives, and that for some time; and the fact that it has not been generally introduced is perhaps conclusive that nothing is to be gained over coal in using it as a fuel. It is a stereotyped expression with Pittsburg people, "We will never go back to coal;" but when you ask what will be done instead, the answer is, "We will make gas from oil or water." To accomplish this last result, the Electric Fuel Gas Co., of Pittsburg was established. Some of the best engineers and mechanics in the world have been engaged by them, and after years of labor, they appear no nearer the desired result than at the beginning.

The views of this gentleman are particularly interesting and valuable, because, in addition to his scientific attainments, he resides in and is familiar with a region of country which, rather than any other, presents the economical merits of natural gas, petroleum, and coal upon a fair plane of competition. He is decidedly of the opinion that "with the enormous quantities of coal to be easily and cheaply produced, it will still be the fuel of at least the next century, although the method of converting that fuel to use as power will perhaps speedily change."

Following this suggestive expression of opinion, which is almost prophetic, I would say that there remains a most interesting field for invention and the application of gaseous fuel. I allude specially to the production of gas from coal, on private premises, and the use of that gas as a fuel.

In one large city in this country, two extensive manufacturing establishments are using gas as a fuel—which gas is generated on their own premises from an inferior article of coal. So great is the economy developed that the manager of one of these establishments told me that it amounted to over 50 per cent. as against the best bituminous coal, and that a vein of natural gas, if known to underlie the plant, would not tempt him to tap it. And yet neither of these large fuel consumers is ready unqualifiedly to endorse this fuel thus generated for economical use under boilers, and for the purpose of the generation of steam alone.

Still I have reason to think and to believe that when slack coal can be bought at a trifling price, compared with the best quality of coal, it can be converted into gas by some simple process, and so its entire value utilized as fuel. I incline to this as an economical alternative rather than to the use of petroleum under present conditions.

So far, after a faithful study of all the accumulated data and information before me, and speaking to and in behalf of steam users, I incline to the belief that nothing as a fuel is to-day superior to a first-class bituminous coal. The superintendent, however, or the chief engineer, should see that the coal goes under the boilers in a proper manner. I would ask no larger fortune than one-third of the present waste of coal in connection with the water-works plants of the United States for one year.

Gaugings of Sewer Discharge Contemporaneous with Rainfall.

BY EMIL KUICHLING, MEM. AM. SOC. C. E.

(*Continued from page 333.*)

3. To obtain the hydraulic slope in case of great depth of flow, or when the sewers are overcharged, the gauges were arranged in pairs, one being placed in each of two consecutive manholes in the same sewer; in the open channels they were likewise arranged in pairs, from 90 to 300 ft. apart. In nearly every instance, these manholes were located at the junction of tributary sewers, and the gauges were placed in such a manner as to be least affected by the inflow of water from such lateral pipes or conduits. It was also noticed that where the bottom of the main sewer was on a continuous grade, the depth of flow at the lower manhole or junction was always somewhat greater than at the upper one, a circumstance necessarily due to the inflow of the contributions from the intervening territory and the lower lateral sewers. Unfortunately, there were generally no intermediate manholes between such junctions, and hence the true hydraulic slope could not be definitely ascertained. It was therefore assumed that when the difference in depth of flow at each pair of manholes was not great, the surface slope would be parallel to the bottom slope, as determined by careful leveling, and that the back-water curve, or "remous" caused by the accretions at the lower manholes would practically not extend up to the upper manholes, since the distance between the two always amounted to several hundred feet. On the other hand, when the sewers were overcharged, the true hydraulic slope was given directly by the gauge records, except in cases where the engorgements were so great as to cause the storm-water to rise above the tops of both manholes and flood the adjacent low grounds; in such event no definite estimate of the flood discharge is possible, and the nearest approximation is the maximum capacity of the sewer under various conditions of flow. Again, when the difference in depth of flow was so great as to warrant the inference that the back-water curve extended beyond the upper manhole, the hydraulic slope for computing the discharge at said manhole was estimated as being somewhat less than the bottom slope, and somewhat greater than the slope given by the gauge readings, in order to compensate for the inflow at the lower manhole.

4. The tributary drainage area behind each gauge

was carefully computed from a topographical map of the eastern half of the city, upon which all existing sewers had been indicated, together with their direction of flow, and relative size. The division lines between the various separate areas are necessarily approximations, as it would be impracticable to define exactly the actual limits in the great majority of cases, owing to the fact that few of the dividing ridges are distinctly marked or noticeable, and that in many instances the natural course of the drainage has been reversed in order to obtain an outfall into existing sewers. Much time and study were devoted to this matter, and it is believed that the errors so made are insignificant. Having thus learned the form and magnitude of each main area tributary to the sewers at the said gauges, computations of the time required for the stormwater from the most distant points on the surface to reach each gauge, by flowing through the tributary and main sewers, were next made, and for this purpose it became necessary to make use of the records of the grades and dimensions of such sewers filed in the office of the City Surveyor. In a few cases the time actually required for the flood to make its appearance, or rather to attain its maximum height, at the gauge was also observed and compared with the computed time, the result being that the former always exceeded the latter by several minutes, thus indicating that the water requires a certain length of time to reach the sewers from the roofs, and more especially from the street surfaces. With the information thus obtained, the increased discharge at the lower gauges could readily be compared with the volume that would probably be delivered by the tributaries which entered the sewer at that point; and where the discrepancy between these two quantities was found to be large, the observations were rejected.

5. Thirty-one of the above described automatic flood-gauges were located in eleven different main sewers and five open ditches or channels within the city limits, whereby an opportunity was afforded to observe the maximum discharge from twenty-four drainage areas, varying in magnitude from 25 acres to 606 acres, and presenting a great diversity of character with reference to quality of soil, density of population, class of roadways, and extent of sewerage. Few of these districts, however, were similar in general character, and hence the final results cannot well be compared. For the sake of brevity, the essential data relating to said districts have been arranged in *Tables No. 16, 17, 18, 19, and 20 hereto appended. It should be stated that in many cases the observations of the flood flow were useless, as no reliable record of the rainfall was at hand: also that of the remaining observations, only those which related to rainfall intensities of about 0.25 in. and upwards per hour have thus far been worked out in detail for some of the most populous and best sewered districts. To a number of these computations, moreover, considerable uncertainty is attached by the reason of the irregularities in grade of the sewers; and hence in the following, the results from only a few of the entire number of districts above mentioned can be submitted with confidence.

6. The discharge was computed with variable coefficients deduced from Kutter's formula, and in a few instances where experiments were made, the computed velocities were found to agree closely with the observed average velocities between the gauges. Weir measurements would doubtless have been far more satisfactory, but, as a matter of fact, none of the sewers were large enough to admit of using this method of gauging during heavy showers. In the distant suburbs, it was possible to find a few places in the natural water courses where a weir could have been applied without damaging the adjacent low lands by over-flow or back-water; yet as the particular object of the gaugings was to find the maximum proportion of rainfall which finds its way into the sewers of the urban districts, the purpose would have been utterly defeated if large tracts of agricultural land had been thus included in the tributary areas. No other process of gauging than by computing the discharge from some approved formula for the flow in a regular channel, was therefore practicable.

7. The percentage of the rainfall which is discharged by the sewers during the period of maximum flow depends, as previously stated, chiefly upon the greatest intensity of the precipitation during the continuance of the storm, and if the average intensity were used in computing such percentages, an assortment of results would be obtained which are manifestly absurd from their enormous magnitude. For example, let us consider the case of the rain on June 2, 1888, when a heavy shower, lasting 15 minutes, was followed by 35 minutes of light rain of probably less than one-fourth of the previous intensity, and by a light drizzle lasting 15 minutes more, after which the rain ended. The rain had thus a continuous duration of 65 minutes, and yielded a total depth of 0.152 inches in all parts of the city, its average intensity being 0.14 inches per hour. On this day, however, the Court and William Sts. outlet sewer showed at the intersection of Alexander St. and University Ave. a maximum flow of 19.97 cu. ft. per second from a drainage area of 132.96 acres; but at the said average intensity, the amount of water falling upon the entire area is only 18.6 cu. ft. per second, and hence on this assumption the sewer would have discharged over 100 per cent. of the average rainfall, which is a palpable absurdity. On the other hand, it was estimated that during the 15 minutes of the heavy shower at least two-thirds of the whole amount of water fell, which would give a maximum intensity of about 0.40 inch per hour, and hence also a precipitation of 53.2 cu. ft. per second upon the whole drainage area; thereby reducing the percentage of the rainfall discharged by the outlet sewer to 37.5, which is doubtless not far from the truth, since about 38 per cent. of the surface may fairly be regarded as impervious. From the data collected by the writer, many other similar instances might be adduced, but it is believed that the foregoing one will suffice as an illustration of the necessity of the most minute and careful observation of the rainfall.

(TO BE CONTINUED.)

* These tables are omitted on account of length, E. K.

The Cove Railway Terminals, Providence, R. I.

In September, 1887, the City Councils of Providence passed a resolution requesting the mayor of that city to appoint a commission of three practical and skilled railroad engineers to examine the terminal facilities of the railroads entering the so-called Cove lands, and to report upon the best plan, in their judgment, for enlarging these facilities, and for new passenger station, freight yard, and freight houses, together with approaches and connections.

Mayor GILBERT F. ROBBINS, in accordance with this authority, appointed JOSEPH M. WILSON, D. J. WHITTEMORE, and ALFRED P. BOLLER, all prominent Members of the Am. Soc. of Civil Engineers, as the members of this commission. These experts on April 13, 1888, handed in their report, of which the following is an abstract: The commission first met in November, 1887, and after a careful consideration of the complex problem, they reported a plan based upon the separation of the freight and passenger interests; a rectification of the main through tracks, so as to allow train movements with the least loss of time; the location of a passenger station convenient of access from all parts of the city, for present and future purposes; the removal of all grade crossings, and the filling in of the old Cove, and its transformation into a public park preferably, though it could be used for business purposes if desired.

The Cove Basin, which is located near the center of the city of Providence, is nearly circular in form and has an area of about 29 acres. It is surrounded by a strip of land called the "Cove Promenade" about 80 ft. wide, laid out in paths and plots of greensward, and thickly planted with trees. Emptying into the Cove Basin are two rivers, the Woonasquatucket river, with a drainage area of about 48 sq. miles, and the Moshassuck river, with a drainage area of about 22½ sq. miles.

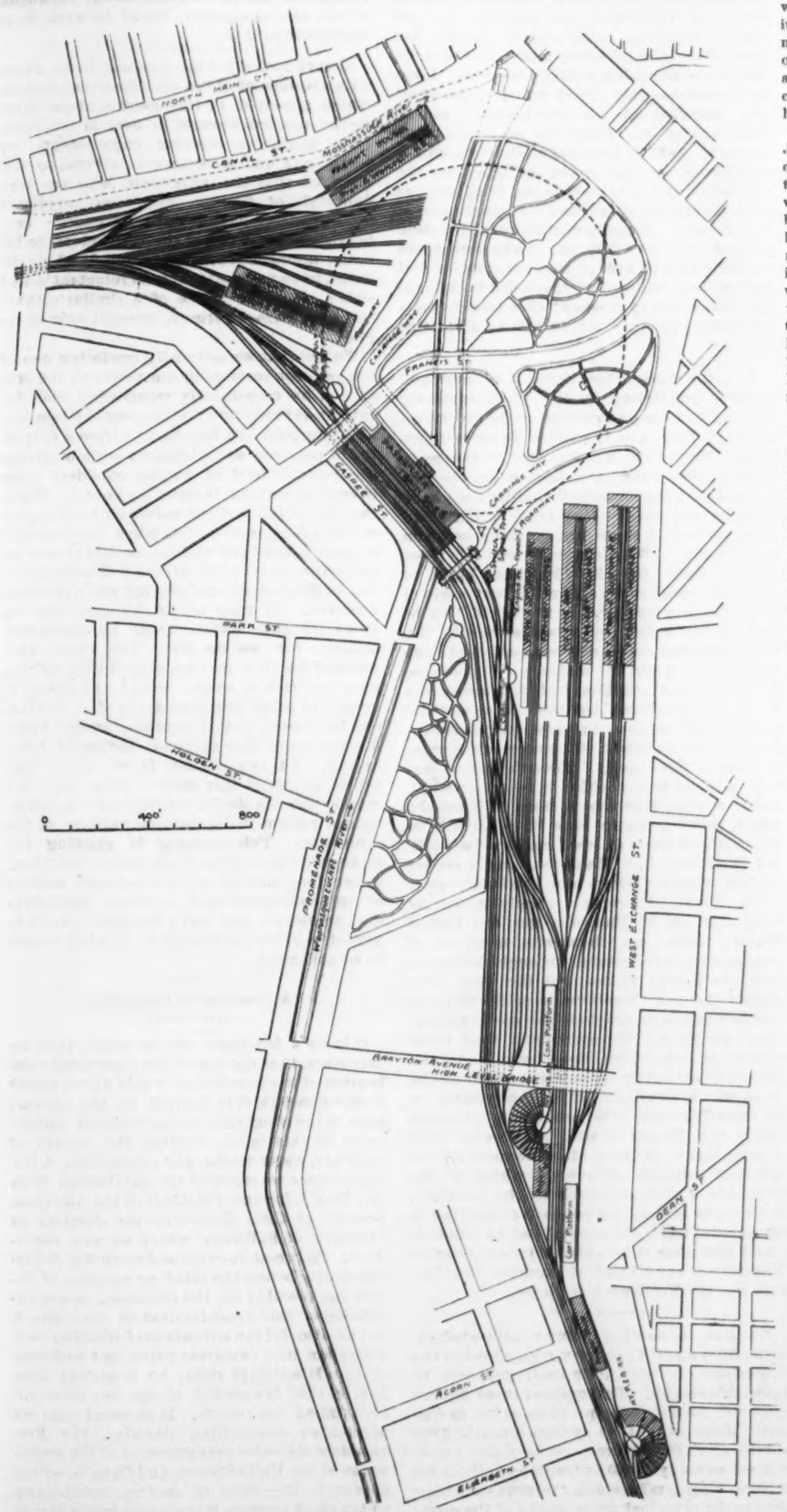
The outlet of the Cove Basin is into the Providence river near the railway passenger station. About 25 ft. below the outlet of the Cove is a dam across the river placed 2.7 ft. below mean high water of the harbor, which is intended to keep the mud bottom of the Cove Basin covered with water at all times. Situated, as the Cove Basin is, so near the center of the city, and being nearly encircled by all the railroads, from the main tracks of which a full view of the basin may be obtained by the passengers on the trains, it has become a noted landmark (or perhaps we should say water-mark) in the city of Providence. For many years, it was to the people of Providence and vicinity an object of pride and affection, and no proposition for filling it received favorable consideration on the part of the citizens. The two rivers before mentioned bring into the basin, which acts as a large settling basin, a large amount of silt, which is deposited, thus gradually shoaling the whole area until portions of the bottom are raised above the water surface even at high tide. In 1876–7 about $60,000 was expended in removing these deposits to a depth of 3 ft. below mean low water. Originally what is now the Cove Basin consisted of the flats adjoining the head waters of the Providence river and harbor, subject to the ebb and flow of the tides, the water clear and salt and abounding in fish; but as the city increased in population and manufactories, and an ever increasing amount of sewage and manufacturers' waste, especially after the construction of sewers, was emptied into the rivers and Cove Basin, what was once a clean and attractive sheet of water became a foul cess-pool, from which were wafted over the city by the summer breezes, noisome and offensive odors.

These changed conditions, together with the urgent demand for more land for enlarged terminal facilities, produced a radical change in public sentiment, and when the plan of the Commission of Experts for enlarged terminal facilities was presented, showing the entire abolition of the Cove Basin except the necessary channel for the rivers, this feature of the plan met with general approval. Soon after the report of the Commission of Experts was submitted, in April, 1888, a Joint Special Committee of the City Council was appointed, of which WM. P. VAUGHN was chairman, to consider the report. Early in the summer this committee was authorized by the City Council to contract for building the river walls through the Cove Basin, and for filling it as soon as the walls were sufficiently advanced.

The City Engineer was requested to have prepared the necessary plans, estimates, and specifications for the work. WM. D. BULLOCK, M. Am. Soc. C. E., Assistant Engineer in the City Engineer's office, in charge of bridges and harbors, was assigned to this work, and the detailed plans, estimates, and specifications were prepared by him. A careful examination of the material where the foundations of the walls were to be built, showed river mud and silt, varying in depth from about 9½ ft. to 16½ ft., underlying which was found a hard stratum of sand and gravel. The depth of the hard stratum below mean high water varies from about 13½ ft. to 22 ft. After a careful study of all conditions, it was decided to excavate all of the mud and silt in line of the new channels down to hard bottom, and deposit within the Cove Basin limits for filling, then refill the excavated channels with gravel up to the bottom of the new river channels. It is proposed to place the bottom or foundation stones of the walls, directly on the gravel, except where there are to be bridges or buildings, when piles, with concrete around the heads, will be used in addition. The bottom of the foundation is started at a depth of 3½ ft. below mean low water, and holds this depth across the basin, the slight longitudinal slope of the river channels being made in the bed of the channel only. The bottom or foundation stones are to be of granite 2 ft. thick, not less than 2 ft. wide, and of sufficient length to extend through the entire thickness of the wall. At low tide the tops of these stones will be only 1½ ft. under water, and by the exercise of proper skill it is expected they can be placed without coffer-dam or drivers.

The walls are to be of granite-faced rubble, backed with ledge stone from the present wall which surrounds the basin, and the whole above low water laid in cement mortar. The foot of the walls is to be protected from washing by the river currents by rip-rap. By the method of construction adopted, it is believed that a better and more stable bed for the river channels will be obtained at a less cost than could be had with pile foundations, while the walls will rest on a secure foundation, and be less liable to displacement when the filling back of them is completed.

It was the intention that the plans, estimates



Cove Railway Terminal Improvements at Providence, R. I.; now under construction.
Note:—The dotted oval shows location of the old Cove Basin.

specifications, and other information relating to the work should be very complete and full, so that an intelligent study of the work to be done could be made by the intending bidders. Blue-print copies of the plans were sent to all intending bidders who applied for them. Ten bids for the work were received, a tabulated statement of which was published in ENGINEERING NEWS of Sept. 8, 1888.

The contract was awarded to the lowest bidder, JAMES J. NEWMAN, of Providence, R. I., the amount of his bid, based on the engineer's estimate of quantities, being $193,920.80. Work under the contract was started Oct. 8, 1888, by beginning the work of building scows, dredge, pile driver, etc., all of which had to be constructed in the Cove Basin, as there is no navigable outlet. But little as yet has been done in actual construction, but the preparatory work is well advanced, and a vigorous prosecution of the work is expected. The work of construction is to be done under the supervision of the City Engineer, and to his satisfaction. WM. D. BULLOCK is the assistant engineer in charge, and HENRY N. FRANCIS, M. Am. Soc. C. E., is the resident engineer.

The work of building the river walls and filling the Cove Basin is regarded as preliminary to the carrying out of the plan for enlarged terminal facilities. The plan submitted by the Commission of Experts has been modified somewhat by the Joint Special Committe of the City Council, WM. P. VAUGHAN, chairman, by making some alterations in the locations of the river channels and by the addition of increased highway facilities. The plan as modified was adopted by the City Council in December, 1888, but as yet no official action, so far as is known, has been taken by the railroad companies looking towards the acceptance of the plan by them. Previous to the adoption of the plan by the City Council, a letter was received by the mayor from two of the railroad companies, in which they ask that work on certain portions of the river channels may be suspended until they can complete certain plans for improved terminal facilities which they have in course of preparation. No action has been taken by the City Council with reference to this communication, unless the action of the Council in adopting the modified plan may be considered as a response.

Road Building.

In a circular on this subject, the dean of the Engineering Department of Vanderbilt University, at Nashville, Tenn., says:

The science of road-making and maintaining, though neither difficult nor abstruse, is nevertheless based on principles so well established and so unvarying in their operation as to render their thorough comprehension an essential to success in securing and maintaining public roads at once efficient and economical, whatever the administrative system by which they are constructed and controlled. In other countries the superintendence of public highways is recognized as an important and responsible duty, and is usually assigned to specially trained, expert government engineers, while in the United States, where the greater mileage makes the economy, if not the efficiency, of roads even more important than abroad, the States depend for this responsible service on private citizens, locally and temporarily appointed to the duty, without providing for them the technical instruction and training so essential to success under any system. To offer such as desire it an opportunity to make good in part this defect, the Engineering Department of Vanderbilt University will admit free of charge to a class in road engineering, one principal or deputy highway official from each county in Tennessee. The appointment shall be made by the chairman of the County Court, and must set forth that the candidate is in a position to be of benefit to the public road system of the county wherein he resides. The course of instruction consists of lectures and work on the economical location of highways to conform to conditions of topography and traffic; principles of construction of new and of reconstruction of old roads, and of maintenance vs. repairs; methods of drainage, simple highway structures retaining walls, drains, culverts, simple bridges; practice in field-sketching, simple platting and draughting, instrumental location and computing estimates of cost study of systems of highway administration.

THOSE who have noticed any further errata in "The Economic Theory of the Location of Railways" are requested to send in a list to this office, as the fourth revised edition is about to go to press.

ENGINEERING NEWS

AMERICAN RAILWAY JOURNAL

Published Weekly at Tribune Building, New York.

VOL. XXI. Saturday, April 27, 1889.

D. McN. STAUFFER, A. M. WELLINGTON — *Editors.*

CHARLES W. BAKER, E. E. R. TRATMAN, M. N. BAKER — *Associate Editors.*

GEO. H. FROST — *Business Manager.*

Subscription. — UNITED STATES AND CANADA, $5.00 *per Year; $2.50 for Six Months; $1.50 for Three Months; Single Copies, 12 cents.* FOREIGN COUNTRIES, $6.56 *per Year, or 3 cents per number additional.*

Drawings and Photographs *of all new engineering works or designs, large or small, of interest from their magnitude, novelty or originality, as well as newly adopted* **Standard Plans** *for engineering structures or details, rolling stock, etc., are always desired for early publication. Also,* **Brief Technical Notes** *of the cost or manner of executing work, tests of materials, machines or other new devices, and* **News of New Construction** *of all kinds.* **Letters** *for publication must be accompanied by the name or card of the writer.*

Drawings for publication *should preferably be in plain black and white, considerably larger than they are expected to appear, with letters and figures in pencil only, all lines clean and bold.*

Coming Technical Meetings.

Western Society of Engineers, Chicago, Ill.—Regular meeting, May 1. Secy., John W. Weston, Gaff Building.

American Society of Civil Engineers, New York.—Regular meeting, May 1. Secy., John Bogart, 127 E. 23d St.

Engineers' Club of St. Louis, Mo.—Regular meeting, May 1. "Some New Theories and Experiments on Boiler and Factory Chimneys," Prof. H. B. Gale; "Experiments on Settling Water," J. A. Seddon. Secy., Wm. H. Bryan, 709 Market St.

Association of Civil Engineers', Dallas, Tex.—Regular meeting, May 3. Secy., E. K. Smoot, 15 No. Jefferson St.

Engineers' Club, Philadelphia, Pa.—Regular meeting, May 4. Secy., Howard Murphy, 1122 Girard St.

Engineers' Club of Kansas City, Mo.—Regular meeting, May 6. "Foundations for the Limfjord Bridge," Otto F. Sonne. Secy., Kenneth Allen, 310 Baird Building.

New England Railway Club, Boston, Mass.—Regular meeting, May 8. "Interchange of Freight Cars" and "Increasing Size of Car Axles," Boston & Albany passenger station.

Civil Engineers' Club of Cleveland, O.—Regular meeting, May 14. Report on Applied Science. Secy., James Ritchie, Case Library Rooms.

American Society of Mechanical Engineers.—The annual meeting will be held at Erie, Pa., May 14, 15 and 16. Secy., F. Hutton, 2 0 Broadway, New York City.

Boston Society of Civil Engineers, Boston, Mass.—Regular meeting, May 15. Secy., S. E. Tinkham, City Hall.

New York Railway Club.—Next meeting, May 16. Rooms, 113 Liberty St., New York City.

Engineers' Society of Western Pennsylvania, Pittsburg, Pa.—Regular meeting, May 21. Secy., S. M. Wickersham, Penn Bldg.

THE picturesque and significant spectacle of the settlement of Oklahoma in an hour sheds a certain light on one of the most important unsolved problems on this continent, the truth or falsity of the claim that there is a vast wheat-growing region in Manitoba and the Dominion's Northwest Territory, which hereafter will be the home of "teeming millions." It is but 48 hours, as we write, since Oklahoma was opened to white settlers. There was then not a known and authorized human habitation in it. Already the newspapers announce with a grave air that "the country is beginning to wear a settled look;" there are reported to be some 40,000 or more people in it, 8,000 of whom are at the single city of Guthrie, not even a stake for laying out a street of which had been driven two days ago. Guthrie has since been laid out and preempted, after divergent views as to the proper location of streets and the proper sizes of lots had been reconciled by discussion, is preparing to hold an election for city officers, and in the feeling words of the special dispatches, "is in the midst of one of the wildest booms ever seen in the West. Her hotels are crowded, but *still* (italics ours) run busses to the depot. Her post-office is demanding more clerical help. *Her banks* are doing a heavy business. Lumber is commanding the enormous price of $30 per thousand on her side-tracks," and so forth and so on. There are also other rival towns of 2,000 to 3,000 population which are competing for the honor of becoming the capital of the Territory, when Congress has passed some law permitting the organization of a Territory. Every available quarter section of land has been taken up. To be sure, there are only 8,000 or 9,000 of these at most, of real agricultural value; but there can be no reasonable doubt that when other larger tracts are opened up, they will be settled almost as quickly.

ALL this shows that there is a large and restless population in the West anxiously looking out for any chance to better themselves. They are inured to frontier hardships; they have a keen eye to the main chance; they know good land when they see it; and they have a catholic indifference as to whether the money they take is Canadian or American if there are as many cents in each dollar. Why do not some of these people make for the Canadian Land of Promise, where there are millions of acres of "the finest wheat land in the world" to be had for the asking by actual settlers? No doubt political reasons have a good deal to do with it. No doubt the majority of these men have a rooted aversion to living under any form of government but their own; and for practical as well as sentimental reasons, believing that the political differences are a great economic drawback. Nevertheless, these men are not in a position to be very critical, and if it were true that a farm in Manitoba was a better thing to have than no farm at all, a few of them at least ought to be working their way into Manitoba. As a matter of fact, however, there are absolutely none going there. There is a steady stream of emigrants out of Manitoba into the United States; there are thousands monthly of foreign emigrants coming through Manitoba into the United States, but the only emigrants who go to Manitoba to settle there, in sensible numbers, are from the eastern Canadian provinces. We apprehend that these somewhat outnumber those who leave the province, so that the population of Manitoba is slowly increasing; but of Americans, or of Canadians and other emigrants who once reach the United States, practically none now go there. Making all allowances for the effect of political differences, which we believe are a real drawback to the province, these facts certainly seem to indicate that in the general feeling of needy Western pioneers —and who should be able to judge better?— Manitoba is not a Land of Promise, and if so, still less the Northwest Territory.

WE give in another column tabulated returns from about 60 water-works, showing the extensions of distribution each proposes to make this season. The totals of these figures comprise 145 miles of pipe, from 30 ins. in diameter down, about 1,000 hydrants, nearly 2,000 valves, and 1 000 meters. Some of the works will set as many as 250 hydrants and others 200 meters. Requests for similar returns have been sent to the principal water-works of the country, and the returns will be published as received. So large a list from so small a number of water-works indicates that there will be much extension this season; and in this connection we may note that if our colored diagram this week could show miles of mains instead of number of works, its phenomenal expansion in the last ten years would be even more marked than it is.

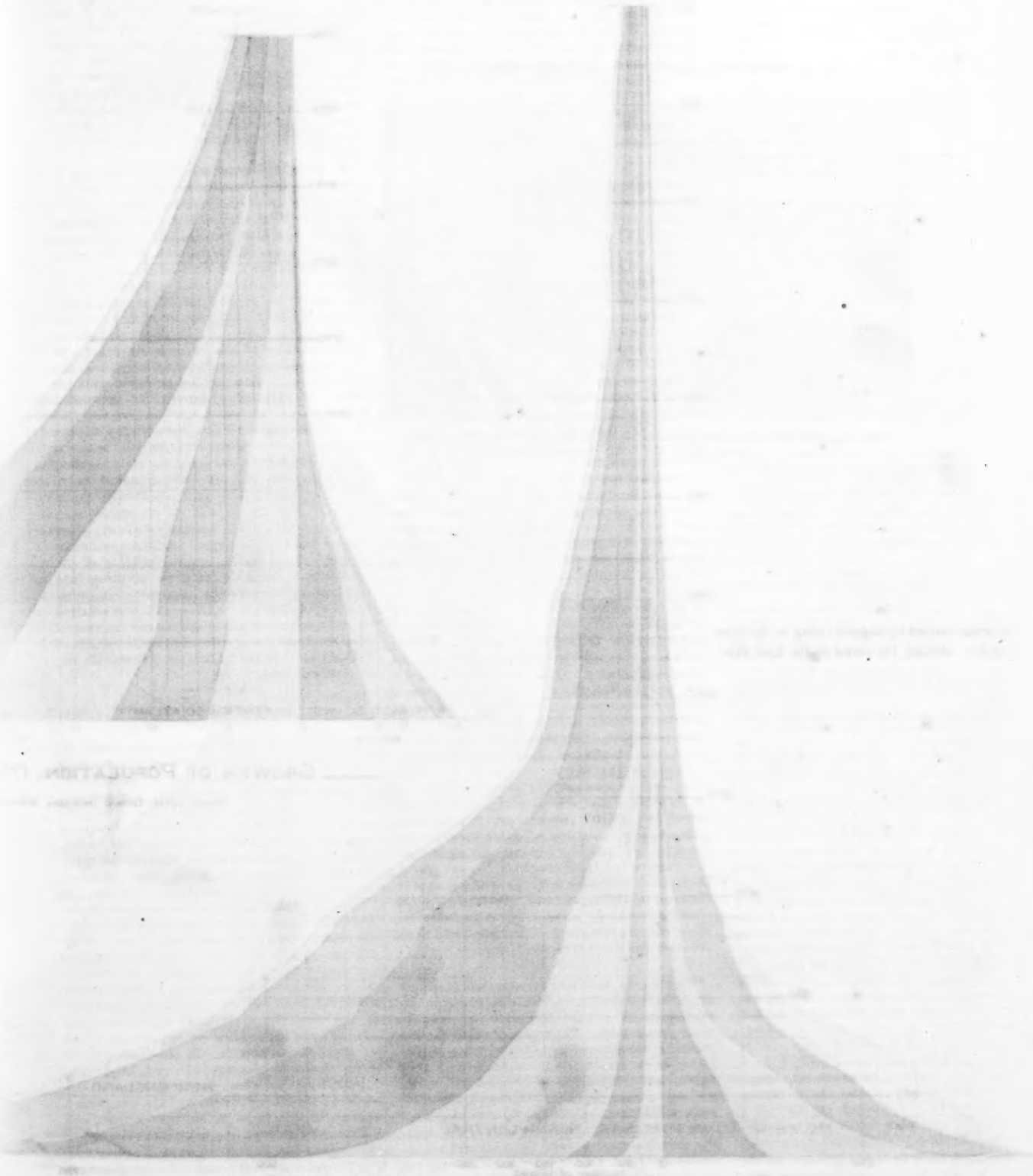
A NOTICE of a vacant position to be filled, with a statement of the qualifications required, which appeared in this journal about three weeks ago, has brought in over 24 responses from engineers desiring engagements, we learn; and among them were several so well qualified that the advertiser, who was very doubtful of finding even one applicant so qualified, has decided to engage two, because at least two of the respondents to his notice appear so thoroughly well fitted for the duties to be assumed that he is reluctant to lose either. Another notice of a similar sort recently, we are informed, brought over 50 replies.

We feel that we are really rendering one of the greatest services in our power to the profession by occasionally mentioning such incidents as these, and pointing out the injustice of filling positions hap-hazard from a limited list of personal acquaintances without giving the possible host of waiting outsiders some chance of making themselves known. When the custom has become universal to thus give notice of vacancies, even when there is only a chance that any outside applicant will be preferred, one of the greatest drawbacks to the profession of engineering will have been removed. It must not be assumed that we speak of this matter from an interested motive, for we do not. The small rate charged for such notices, even if they filled a page or two a week, would not leave a margin of profit worth speaking of or seeking, except, indeed, that everything which benefits the profession at large indirectly benefits us. But we do not, if we know ourselves, speak of this matter from any other motive than a desire to introduce a much-needed reform in the general practice of the profession. This country is growing too large, and the number of engineers too great, to get along without some recognized method of intercommunication between employers and employed, and every engineer owes it to himself and his profession to do what he can to establish this.

A Century of Progress.

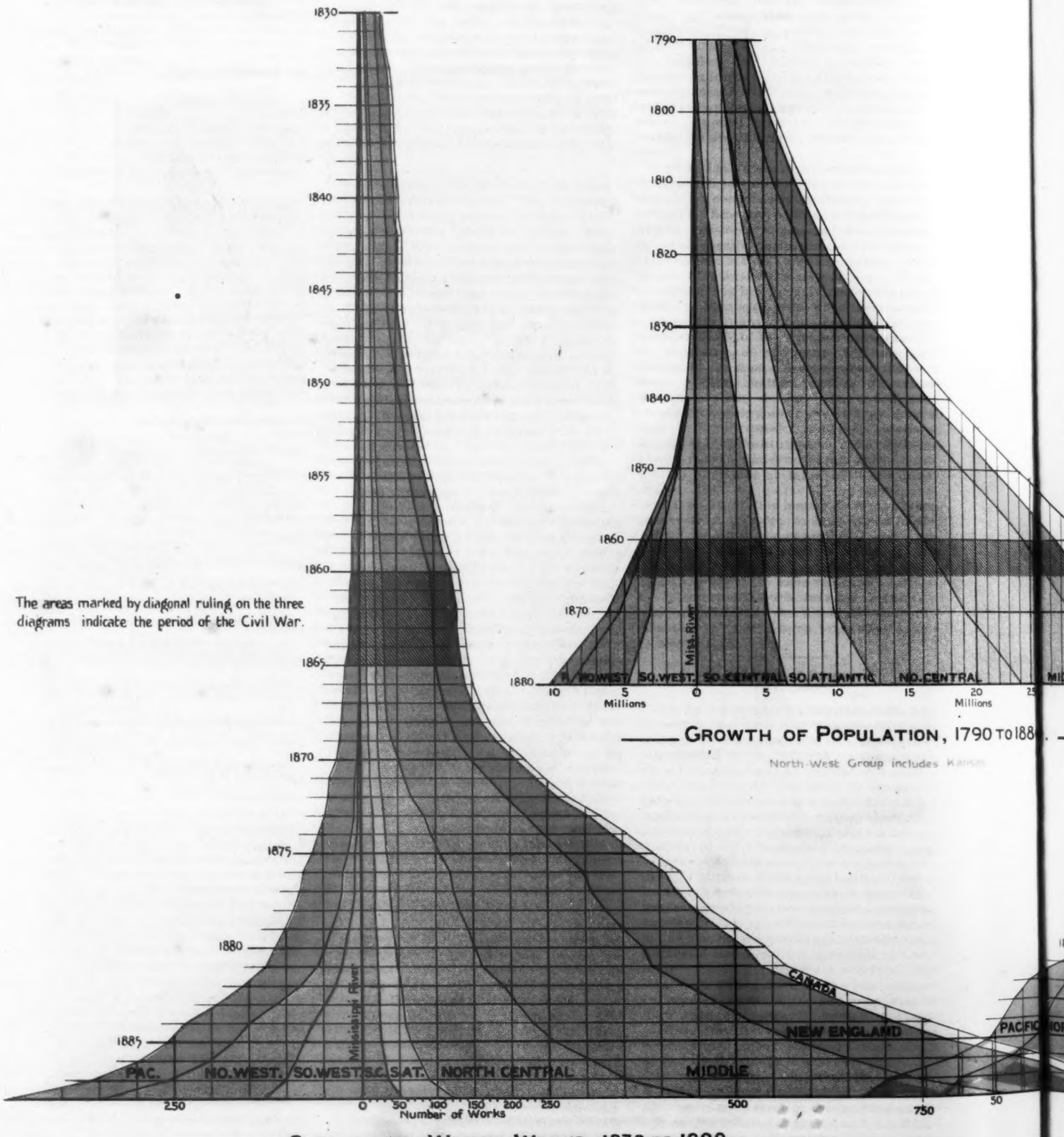
(WITH INSET.)

It is by a fortunate chance rather than by intention, that the eve of the centennial celebration of the foundation of this Government is signalized in this journal by the appearance of the diagrams on our colored supplement in this issue, showing the growth of railways, water-works, and population. A few weeks since we received for publication from Mr. MAX J. BECKER, President of the American Society of Civil Engineers, the diagram of "Growth of Railways" which we now reproduce. Its great interest and merit for bringing clearly before the mind, as no array of figures can possibly do, the enormous recent expansion of this great interest at once struck us; as also did the advantage of dividing such a diagram into two great parts, east and west of the Mississippi river, by a central base line, so that the growth of the two parts can be studied separately. It chanced that we were then completing, likewise, the first complete statistics ever gathered of the water-works of the United States and Canada, which appear in this issue in another article, and which show an even more remarkable recent expansion than do the railways. These statistics were already made up for the same grouping as the railway diagram, and the added interest which the diagrams of both railways and water-works would gain by being published together, led to the construction of



Diagrams showing Growth of Railways, Water Works.

STATES ARE ARRANGED IN GROUPS EAST AND WE
(See heavy dotted line o



The areas marked by diagonal ruling on the three diagrams indicate the period of the Civil War.

GROWTH OF POPULATION, 1790 TO 188

North-West Group includes Kansas

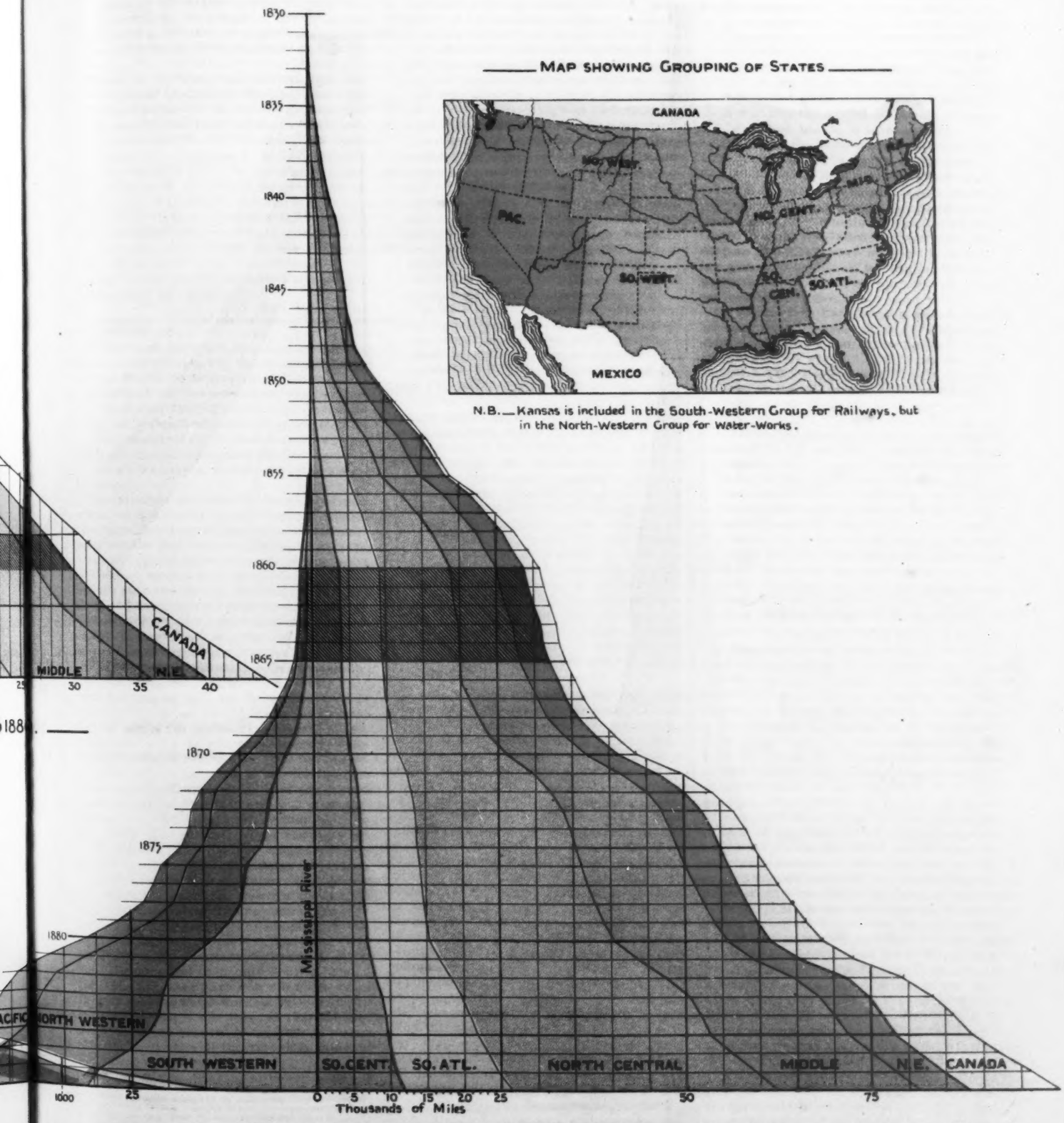
GROWTH OF WATER-WORKS, 1830 TO 1888.

CHAS. HART & SONS. LITH. 36 VESEY ST. N. Y.

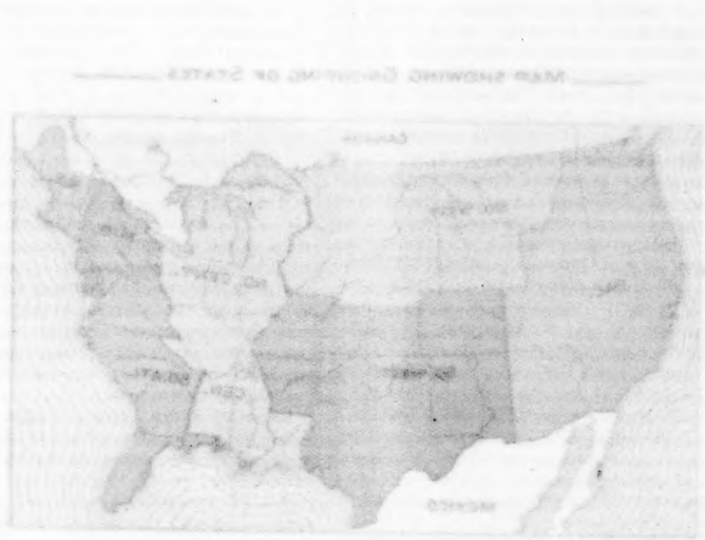
ORKS, AND POPULATION; UNITED STATES AND CANADA.

AND WEST OF THE MISSISSIPPI RIVER.

ced line on Map)



GROWTH OF RAILWAYS, 1830 TO 1888.



the latter also, and to make them complete, and their lesson readily intelligible, it was evidently necessary that a similar diagram of population also should be added. These three diagrams, accordingly, are given; and to further assist in studying and interpreting the evidence of vast material progress which they give, we have added a map showing the grouping of the States and Territories used in preparing the diagrams. Every group has been given a different color, and each has the same color in all three diagrams and on the map.

There is, however, one exception to the uniformity of grouping in the diagrams,—the State of Kansas. In the railway diagram and in the map Kansas is included with the Southwestern group. In the diagram of water-works and of population it is included with the Northwestern group, where it more naturally belongs in other than geographical respects. Northwest and Southwest, however, are both so rapidly advancing that there is little distinction between them, and perhaps it would have been better to include Kansas with the Southwest in both diagrams. Its population and number of water-works at various censuses has been:

	1888	1880	1870	1860	1850
Population	?	996,096	364,399	107,206	none
No. Water-Wks	72	1	none		

From these figures a line may be plotted to include Kansas in the Southwestern group instead of the Northwestern, if desired.

But one of the three diagrams extends over 100 years, and that, if we may perpetrate an Irish bull, extends only over 90 years; but it is easy to extend all three of them over 100 years mentally, and to appreciate the full moral to be drawn from them, this should by all means be done.

The diagram showing the progress of railways, covering the period 1830-1888 inclusive, is easily extended mentally, for the very good reason that back of 1830 there were no railways. A few miles of rude track had been built a few years before that time, but it was not till then that JERVIS invented the locomotive truck, and the results of the great Rocket trial of October, 1829, became generally known in this country, and started the movement whose vast extension our diagram shows.

The water-works diagram, which covers also the years 1830-1888 only, does not exactly start from nothing at 1830, for there were then 31 water-works in the United States, as is more fully shown in the tables of our succeeding editorial, and even in 1880 there were 5 water-works, of which 3 existed in 1790; but practically the whole water-works interest, as well as the whole railway interest, has been created since 1830, and it results in no error of importance to consider it as starting at that date; for the works that existed before 1830 were all small affairs, and did not average nearly as high in cost as the 1701* water-works which now exist in the United States. The Croton Aqueduct, for example, was not opened till 1842; the Cochituate (Boston) works, not till 1848. The Fairmount (Philadelphia) works were well started before 1830, and were then by far the most important works on the continent, but they had then only 5 miles of pipe laid, whereas they have now 876 miles. The average cost per water-works is quite certainly as large now as it was then, so that the diagram showing growth in number of works also shows fairly well the growth in miles of mains and cost of works.

The population diagram, although covering 90 years instead of 58, fails far more seriously than the others of fully showing the progress of a century, in that it lacks the eight years since 1880 in which an enormous expansion of population has taken place, the population of this country being now not less than 65,000,000, instead of the 50,155,783 of 1880, and likely to be about 67,000,000 (possibly over 68 million) by the middle of 1890; in other words, if the population diagram could have been extended down to the end of 1888, like the other two diagrams, the length of the present base line for 1880 would have to be increased by considerably more than was the *total population* for 1830, when it was only 12,866,020. It was not till about 1835 that the population became as great as 15,000,000.

As a matter of record we give in another column the table from which the population diagram was constructed, showing the population of each group of States at each decennial census from 1790 to 1880 inclusive. It was a matter of considerable labor to compile this table, and as it has never been compiled before, it will no doubt be studied with interest. To make it more complete we have added another table showing the percentage of increase of population from decade to decade.

To make the diagrams more easy of interpretation and comparison, we have symbolized the dark days of the civil war by a belt of dark shading on each diagram covering the five years 1860-65. Actual warfare extended only over four years, 1861-65; but the political condition was so unsettled in the year before the war that practically all enterprise was killed, and the dark days of shadow extended over fully five years, as is strikingly shown by both the water-works and railway diagrams, which it is to be remembered are compiled for records for each year independently, and yet show a sharp break at 1860, when it first became clear that war or disunion was at hand. This shaded belt is not carried across Canada, partly to help to distinguish it from the United States, and partly because Canada lost little or nothing by the war. It lost indirectly, as all countries do from the misfortunes of others, but on the other hand it gained greatly and directly from the exceptional market opened for its produce and otherwise, so that on an average it neither gained nor lost by our civil war.

The population diagram shows less effect from the civil war, as is but natural. Nevertheless, the depressing effect is clearly visible there, and as a matter of fact it depressed the rate of growth from the wonderfully uniform rate of 34.61 per cent., which had obtained before the war, to 22.63 per cent., a decrease which meant a loss of 4,072,000 inhabitants; *i. e.*, the population in 1870 would have been 42,630,000 instead of 38,558,371 except for this decrease in rate. As the old rate has been nearly resumed since 1870, and will almost certainly prove to have been maintained and increased in the 1880-90 decade, we are justified in ascribing this loss entirely to the war. Canada likewise shows in a similar way the effect of the war, as will be seen from the decennial rates of increase given in another column, and has been increasing but slowly in population since 1851, owing to the fact that about one-fifth of its inhabitants find it profitable to seek a home in the United States. Why this should be so is tolerably clear from our diagrams alone. The wider field and more rapid growth of the United States offers the enterprising man better opportunity, and hence the full measure of the loss to Canada is not given by the figures alone. It is to a large extent (of course with many exceptions) the more vigorous and capable of her young men who are drawn away from her, leaving the lame and the lazy behind.

In railways, Canada makes a most excellent showing, having almost as great a mileage in proportion to population as the United States. Dividing the 1880 population (1881 in Canada) by the 1887 mileage, gives 350 inhabitants per mile in Canada and 334 in the United States; and since 1860 Canada has increased her mileage nearly six-fold, whereas the United States has increased a little less than five-fold. It is to be remembered, however, that the Canadian railways have been largely created from the public funds. Not less than $163,828,262 in cash, apart from $21,592,000 of loans, and gifts of public lands, is credited as having been expended either in building government lines or in colonial, provincial, and municipal aid, extended not as a loan but as a gift, amounting to the large average of $13,260 per mile of railway, or probably nearly half of the entire actual cash cost of the system per mile. How vast a sum this is proportionately will be better appreciated by remembering that it is equivalent to the free gift of $2,000,000,000 in aid of the United States system. Had such an amount of government aid been floating around, it is difficult to surmise what proportions our railway system would have reached by this time.

In water-works Canada makes a much inferior showing, and yet that it is really a good showing, in proportion to wealth and population, our succeeding article shows. It should be particularly noted that Canada suffers on all the diagrams, but especially on that for water-works, from being shown on the outside of it; the strip devoted to it becoming so oblique near the base as to greatly diminish to the eye the quantities which it represents. The same occurs in less degree with the New England and Pacific strips. The nature and extent of this effect can be studied in the tonnage diagram below, added for another purpose. The dotted "canal tonnage" line at the bottom of the diagram represents precisely the same ordinates as have been laid off above the railway tonnage line to give the total tonnage line; but from being laid off from a straight base line, instead of from an irregular and much inclined one, the effect to the eye is very different.

Comparing the trans-Mississippi with the Eastern group of the United States, it will be seen at once how recent and how enormously rapid has been the development of that region. Before and during the war there was a considerable population in it (about one-sixth of that east). Railways and water-works were almost *nil*. In 1880, great development in both had taken place, and nearly one-fifth of the water-works and one-third of the railways were located there; but the immense development since then, and the close approach to equality with the cis-Mississippi region which the far West shows, must be a surprise to every one who examines the diagrams, and a significant and impressive evidence of what the future has in store for that section. It is but yesterday that all this vast region was a *terra incognita*, and more than half of it given over on the maps to the "Great American Desert" and the Rocky Mountains, but it already includes two-thirds as great a railway mileage as there is east of the Mississippi, and over 40 per cent. as many water-works, while the rate of growth in both is so much more rapid than east of the Mississippi that we may reasonably anticipate that the day is near at hand when the Mississippi will bisect our railway system, and perhaps also our water-works, if not our population. We have only to contrast our two large diagrams with that of population to see at once that (1) the growth of the far West population since 1880 must have been exceedingly rapid, and (2) that the railways and water-

* The number included in the summary of our succeeding editorial is 1666, besides which we have notes of 35 other works described in the supplement to our forthcoming Water-Works Manual; 46 water-works of unknown date, moreover (nearly all of them really constructed within the last year or two) are omitted wholly from the diagram, which shows therefore only 1620 water-works, or just 5 per cent. less than the actual number.

works must both have been built for the future, in advance of present demands. But for what future? It seems quite certain that those on the ground must see a greater future for the region than we have yet realized at the East, or they would not have been preparing for it on so grand a scale.

But the greatest of all lessons to be learned from these diagrams is not by contrasting one section or one group with another, interesting as it is to do so, but by considering them as a whole. They tell a story of rapid material advancement which quite staggers the imagination, and is so incredibly rapid as to be calculated to excite anxiety and dismay rather than exultation in the mind of a rational man. It is possible to have too much of a good thing, and while reasonably rapid, healthy progress may be regarded with unmixed satisfaction, we may yet see that we have almost as much reason as had King MIDAS to regret the faculty with which we seem to be endowed, of turning everything into gold forthwith. The picture would be the same for a dozen other interests as for those we show, if presented in the same way. Iron and coal production would show even more remarkable expansion. The volume of fire insurance is one of the most direct evidence of relative wealth. Exact statistics for the whole United States are not available,

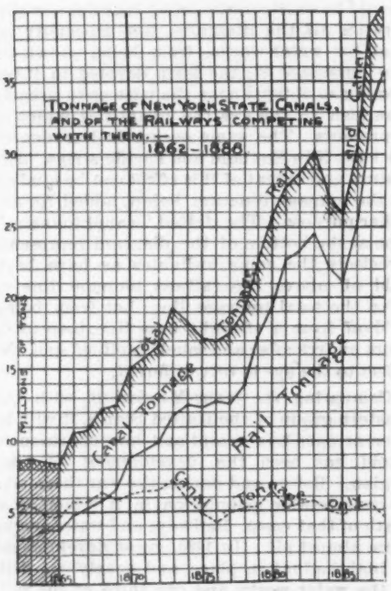


Diagram showing Growth of Tonnage of the Erie Canal and of the Chief Railways competing with it (New York Central & Hudson River, New York, Lake Erie & Western, (excluding the N. Y. Penna. & Ohio), and Delaware, Lackawanna & Western) 1862 to 1888.

but it is estimated that the companies doing business in the State of New York carry from 80 to 85 per cent. of that of the whole country; and the amount which these companies had at risk was in

1868	$ 3,136,439,700
1878	6,300,179,021
1888	12,290,325,078

In other words, the insurable property of the country has nearly doubled every ten years, and has increased even faster than the miles of railways, although not so fast as the number of water-works. Land values, which need no insurance, increase less rapidly, but even these increased from $308 per head in 1850 to $870 per head in 1880, or as 2.82 to 1 (41.4 per cent.) per decade, indicating an average rate of growth in total valuation of about 88½ per cent., or nearly as great as the rate of increase in perishable property. Railway tonnage has also increased far more rapidly than railway mileage, as the accompanying diagram, showing the growth of the tonnage of both the Erie canal and the chief railways competing with it from 1862 to 1888 inclusive, will seem to indicate.

It is true that our great material progress since the war has been only the most marked effect of a world-wide period of prosperity, for all nations have been advancing in this period as never before; but there has been nothing in the experience of any nation in any age approaching such sudden expansion as our diagrams bear witness to. Turn the diagrams upside down, which gives perhaps the most impressive view, and we have almost a picture of the mushroom which would seem the nearest parallel in nature to such sudden growth. Extend the diagrams in imagination for another century, nay, even a quarter of a century, or even another twelve years to the end of this century, and what will they have become? The population diagram would seem to admit most readily of such extension, while yet keeping within the bounds of reason; but were that extended to maintain the same ratio for the next century as has obtained during the past one, it would show a population in 1989 of over 1,000,000,000 and at various lower ratios the population chart would expand into:

	In 1939	In 1989
At 30 p. c. increase per decade....	241,000,000	896,000,000
At 25 " " "	198,000,000	605,000,000
At 22.63 " " "	180,000,000	500,000,000

(i. e., that of the war decade)

The other two diagrams expand beyond all seeming reason and probability, if extended even ten years.

What is to be the effect on the character of the people and their government of such limitless growth in material prosperity as these facts foreshadow? For one thing, it should excite charity for the shortcomings of our Government and our corporations. No political machinery can be adjusted to meet such rapidly expanding duties. For another thing, as we have stated, it should excite anxiety for the century just opening before us, or anxiety mingled with exultation, among rational Americans. For nations, even more than for individuals, there is such a thing as growing rich too fast.

Shall They Vote away the Right to Vote?

For reasons somewhat difficult to understand in this latitude, some of the members of the Engineers' Club of Philadelphia are advocating radical changes in the constitution and by-laws of that society, and in particular the suppression of the letter-ballot, and the substitution for it of an individual vote at the headquarters in Philadelphia.

The effect of this new movement, if carried to a successful issue, would be to leave the non-resident members, who constitute the majority of the Club membership, "entitled to all Club privileges," *except* the very important one of exercising their proportionate power in the management of its affairs. To outsiders this appears to be going backward with a vengeance, in direct opposition to the custom and practice of all of our national engineering societies, and to the very line of policy that has made the Engineers' Club of Philadelphia the most prosperous and useful of the younger engineering organizations. According to the last annual report, the Club numbered 497 members, and of this number 229 were residents of Philadelphia, and 268 fell under the head of non-resident members. It is the majority, therefore, that would be practically deprived of the right of voting, for very few among these outsiders could find the time to travel fifty miles or more to the Club headquarters simply to deposit a ballot.

We do not wish to ascribe any improper motives to the movers in this departure, and can only look upon the suggested change in policy as the result of hasty and undigested action. But it will do no harm to point out to them some of the more objectionable features, as they are sure to appear to non-resident members. In looking back over the records of the Club, it seems that the average attendance at the annual meetings is about 60 members, and consequently a majority of this number, or say about thirty men, would absolutely control the organization and management of a club numbering about 500 members. If it were the intention of this change to place the club interests in the hands of a very small minority, the scheme could not be better devised; and with this one amendment legally adopted, the thirty odd members would virtually own the Club, which would itself be powerless to prevent any further amendments no matter how objectionable.

It is hardly necessary to say that the mere possibility of any such minority rule would be fatal to the future of this society; and speaking only from anxiety for the welfare of the Club, we would strongly advise against the adoption of any such amendments as proposed, which we feel assured that the proposers will, on serious second thought, withdraw. The welfare of this vigorous engineering society should be dear to every one of its members, whether they reside in Philadelphia or outside of it, and as the non-residents (much more so than resident members) must necessarily depend upon the Board of Direction as their sole representatives in whatever action is taken in advancing Club interests, it is absurd to say that only the minority should have a voice in the selection of this Board, and that no non-resident should have a place upon it. We, however, have no doubt that the good sense and self-interest of the majority of the Club will very effectually dispose of this, we hope unintentional, effort to deprive them of their votes and so to sap the life of one of the most flourishing of all the engineering societies of this country.

The Water-Works of the United States and Canada.

The summaries for the whole United States of the statistics which have been so far given for the various groups of States separately appear in the following tables and are in a sense the most interesting of all. To facilitate comparison and save space, the statistics for Canada have been given in the same tables after the totals for the United States. In comparing them, it needs to be remembered that the population of Canada was only 9.4 per cent. of that of the United States in 1870, 8.6 per cent in 1880, and is probably now not over 7.7 per cent, as much, or 5 million against 65 million, if indeed so much. Moreover, the urban population, in towns of over 4,000 inhabitants, was only 0.72 against 12.94 millions, or 5.6 per cent. as much.

Tables 1 and 2 show that the total number of works in Canada (excluding 3 in Newfoundland) is 68, against 1,666 in the United States, or 4.75 per cent., the total capital invested being 21 against 432 millions, or 4.95 per cent., and the miles of mains (Table 4) 5.65 per cent This and other data given show that Canada is somewhat behind the average of the United States in its water supply conditions, but not materially.

The number of water-works at the end of each decennial period may be summarized from Tables 1 and 2 as follows:

	N. E	Mid.	No. C.	E. of Miss. Riv.	W. of Miss. Riv.	Total U. S.	Canada
1800	1	3	—	5	—	5	—
1810	3	9	—	13	—	13	1
1820	5	10	1	17	—	17	1
1830	6	15	2	29	2	31	1
1840	9	18	5	46	3	49	2
1850	12	30	7	65	3	68	6
1860	26	64	10	123	9	132	10
1870	60	97	27	209	31	240	12
1880	136	215	107	514	115	629	31
1888	286	433	329	1,176	490	1,666	71
P.C. inc. fr. 1880.	111	101	208	129	326	165	129

Nothing except the diagram which is given on the inset in this issue could more vividly set forth than these figures the enormous recent growth of water-works as compared with past progress. It hardly admits of doubt that by 1890 there will be over 2,000 water-works in the United States, more than two-thirds of which will have been built since 1880, and *all but* 240 of which will have been built since 1870, when we were in the habit of looking on this country as pretty well advanced in all such matters. The retarding effect of the war is very evident in Tables 1 and 2, only 23 works in all having been built in 1861-5, and only 79 in 1866-70. Singularly enough, only two water-works were built in Canada during this period, although Canada suffered little directly and profited much from our war.

The total number of water-works in Canada is so small that it has not seemed worth while to summarize the water-works for each province separately, further than is done in Tables 4 and 5 I-J at the end of this article. The total number of works in each province at various dates was:

	1850	1860	1870	1880	1885	1888
In Ontario ...	2	4	5	14	21	35
Quebec.....	1	2	2	10	12	16
Manitoba.....	—	—	—	—	1	1
British Col...	—	—	—	—	—	2
New Brun....	—	2	2	3	5	6
N. Scotia....	1	1	1	2	4	7
Prince E. I.	1	—	—	—	—	1
Tot. D. of C.	5	9	10	29	43	68
Newfoundland.....	1	1	2	2	3	3

It will be seen that Ontario has more than half the water-works of Canada, but it has likewise 45 per cent. of the population.

Table 4-S shows that the present aggregate of capital invested in the 1,666 water-works of the United States is the enormous sum of $432,225,546, or about $6.65 for every man, woman, and child in it. Large as this sum is, however, it is only 1 per cent. of the estimated total wealth of the United States in 1880 (43,642 millions) and not much over one-half of one per cent. now. Still, it represents nearly one-tenth as great a capital as that actually invested in railways, which was in 1888, according to *Poor's Manual*:

Stock.....	$4,191,562,029
Debt.....	$4,186,943,116
Against water-works cost.	432,225,546

The water-works cost is nearly all actual cash expenditure, whereas the actual cash paid out for railway construction and equipment is little if any more than half the aggregate of stock and bonds.

In miles of main we have:

Water-works mains.....	24,257 miles.
Railways	149,913 "

Or but little more than six times as many miles of railway as miles of main. Considering that these water mains are all concentrated in the small area of cities, and considering the enormous distances of railway lines between cities, this is a remarkable contrast.

The population statistics given in Table 6 will be interesting in themselves, as similar records for the groups of the United States have never been made up before. The increase of total population per cent. of the three Northeastern groups (New England, Middle, North Central) will be seen to have been very small between 1870 and 1880 (15 to 23 per cent.) against a very large growth (27.2 and 31.6 per cent.) in the two Southeastern groups. This was explained at the time as due largely to defects of omission in the 1870 census, but still it is notable that, even in 1870-80, the North Central group was sending out emigrants rather than receiving immigrants. This appears clear from the fact that the natural rate of increase from births in the United States has been determined to be about 2 per cent. per annum, or 21.9 per cent. per decade, whereas the total increase of the North Central group was only 22.8 per cent., Wisconsin still receiving many immigrants. The three Far West groups show very heavy rates of increase, and Canada, a very small one. As a matter of interest in this connection, we may note that New Brunswick increased in population 12.5 per cent., Nova Scotia, 13.6, Quebec, 14.1, and Ontario, 18.6 per cent., the average of the Dominion being 17.2 per cent.

Table 7, showing sizes of towns supplied, may be abstracted by percentages as follows: The record showing that the proportion of works in small towns is rather below the average in Canada, and enormously above it in the far West (trans-Mississippi) region. The census records are over eight years old, which partly explains the contrast, as the Far West has been growing very fast; but, even allowing for this, the proportion of small town works must be larger in that section than anywhere else.

	N. E.	Mid.	So.	No. C.	Far W	Total U. S.	Canada.
Towns of 1,000 or under	13.9	10.9	17.2	10.8	40.0	20.3	13.3
" " 3,000 " "	41.8	51.0	49.1	42.2	74.4	54.2	33.9
" " 5,000 " "	64.3	69.0	60.6	63.0	86.8	71.6	55.9
" " 10,000 " "	81.2	87.0	78.6	83.8	92.8	86.3	83.9

As an average, 97.6 per cent. of the Canadian census city population have water-works, while 114.9 per cent. of the corresponding United States population have them, the proportion being singularly uniform throughout the groups.

Table 8 shows that the cost of works per head is quite uniform at $18 to $35 in the various groups, the Pacific group showing abnormally high ($71.80) because the population has been growing very fast there since 1880. The same cause operates to increase the cost per head in all the groups, and the real cost for the whole United States is probably considerably under $25 per head potentially supplied, with a revenue per head of about $2.40, the actual revenue per head being $2.65 both in the United States and Canada.

The cost per mile of main shows even less variation, ranging from $13,070 to $21,580, averaging $17,800 against $15,560, in Canada. The revenue per mile of main is also tolerably uniform, being least ($1,203) in New England, greatest in the Southwest ($2,000), averaging $1,620 against $1,426 in Canada.

The per cent. of revenue to cost is very extraordinarily uniform, at a little over 9 per cent. both in the United States and Canada, the most marked exception being in New England, where it is only 7.54 per cent.

The cost and revenue per tap shows more variation, being very high in the far West, although the population per tap there, even by the 1880 census, is rather above the average of the United States. The population, cost, and revenue per tap in Canada are all extraordinarily low, indicating strongly that there is some error in the reported number of taps in Canada. We have endeavored to locate this error, if there be one in fact, yet without success. We leave the figures to speak for themselves, therefore, until our next annual issue.

The statistics as to kinds of works, given in Table 9, are interesting, not only in respect to the widely varying proportion of gravity works, but in respect to the curious contrast which they show in forms of pumping works. The percentages of pumping works of the various types in the several groups is as follows:

	Percentage of Works Pumping to: Reservoir.	Tank.	Stand-pipe.	Direct.	Total.
New England	40.6	17.1	25.2	17.1	100.0
Middle	49.8	14.1	18.9	17.2	100.0
Southern	32.4	22.2	31.5	13.9	100.0
North Central	14.8	16.5	24.2	45.5	100.0
Northwestern	22.7	24.6	29.5	23.2	100.0
Southwestern	23.7	21.9	36.0	18.4	100.0
Pacific	49 5	30.3	7.6	13.6	100.0
Total U. S.	30.7	18.6	25.0	25.7	100.0
Canada	18.8	10.4	8.3	62.5	100.0

Direct works are the leading type only in a single group, the North Central, and in Canada. Stand-pipes predominate over tanks in almost every group, but largely in none. The use or non-use of reservoirs largely depends on topography, and so is less significant.

Table 10, of sources of supply, explains itself. It will bear study by those interested, but demands no further comment than has been already given in reviewing the separate groups. The heavy excess of river and lake supply in Canada, however, and non-use of wells, is notable.

Tables 11 and 12, giving working and fire pressures, we likewise leave to speak for themselves. From them the tendency of practice in any group may be at once determined. The most common working pressure for the whole United States, and likewise about the average pressure, will be seen to be about 65 lbs., and the most common fire pressure by far, 100 to 109 lbs. Out of 1,327 works reporting their working pressures, only 642, or about half, report higher fire pressures, nearly all of them of course being pumping works, of which there are 1,147 in all in the United States.

Table 13, on ownership of works, shows that a fraction over two-thirds of all the water-works population is supplied by public works, and over three-fourths in Canada. In the far West the proportion of public ownership is very small. No less than 45 water-works are reported as controlled by "outside companies," or by the syndicates which have recently been formed and have done much useful work in introducing water-works. As many as 74 United States and Canadian water-works are owned by individuals.

Table 14, on use of meters, shows that there are already 107,415 meters in use (with 2,077 more in Canada) or about 1-19 of the taps. From Table 8, it will be seen that in proportion to taps, meters are by far the most common in the Pacific and New England groups, and much less used in Canada than in any of our groups. But 99 works, however, report over 100,000 of these meters, leaving nearly 1,600 works with few or none in use. The field for the further introduction of meters is therefore very great.

The hydrant rentals, shown in Table 15, need no special comment, nor have we space for it, although this Table will have as great practical interest, perhaps, as any other. The variations in different groups, and in the same group, are great.

Table 16, showing pumping capacity, we must also leave to explain itself, calling especial attention to the note beneath it. It shows the enormous aggregate of 3,725,100,000 galls. daily pumping capacity, or about 34 times the present daily supply to New York City. The enormous volume of such a quantity of water will be better appreciated when

TABLE 1—S.

UNITED STATES AND CANADIAN WATER-WORKS.—SUMMARY OF DATES OF CONSTRUCTION BY GROUPS OF STATES.

Date of completion taken when construction extended over more than one year.]

YEAR.	Water-Works Built.									
	N. E.	Mid.	So. At.	So. C.	No. C.	N. W.	S. W.	Pac.	Total U. S.	Canada.
Before 1800	1	3	1	.....	.....	.....	.....	.....	5	.....
1800 10	2	6	.....	.....	.....	.....	.....	.....	8	1
1811-20	3	1	.....	.....	1	.....	.....	.....	4	.....
1821-30	1	5	3	1	1	.....	1	1	13	.....
1831 40	3	3	3	6	3	.....	.....	1	19	1
1841-50	3	12	1	1	2	.....	.....	.....	19	4
1851	1	3	.....	.....	.....	.....	.....	.....	4	.....
1852	1	4	.....	.....	.....	.....	.....	.....	5	.....
1853	.....	2	.....	.....	.....	.....	.....	2	4	1
1854	(1) 2	3	1	.....	.....	.....	.....	.....	(1) 6	.....
1855	4	2	.....	.....	.....	.....	.....	.....	6	.....
1856	1	3	1	.....	1	.....	.....	.....	6	1
1857	2	(1) 5	.....	.....	.....	.....	.....	1	(1) 8	.....
1858	.....	2	2	.....	.....	.....	.....	1	5	.....
1859	1	5	.....	.....	.....	.....	.....	2	8	1
1860	(1) 2	4	.....	1	2	.....	.....	.....	(1) 9	1
1861	1	2	.....	.....	.....	.....	.....	1	4	.....
1862	3	.....	.....	.....	1	.....	.....	3	7	.....
1863	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
1864	1	1	.....	1	.....	.....	.....	1	4	.....
1865	1	2	.....	.....	.....	.....	.....	5	8	.....
1866	1	3	.....	.....	1	.....	.....	2	7	.....
1867	(1) 2	5	.....	1	.....	1	.....	1	(1) 10	.....
1868	(1) 4	6	.....	1	1	.....	.....	2	(1) 14	.....
1869	(1) 9	4	.....	.....	5	.....	.....	2	(1) 20	.....
1870	(3) 4	10	.....	1	9	2	.....	2	(3) 28	1
1871	(1) 2	16	1	.....	5	2	1	7	(1) 34	.....
1872	7	12	1	2	8	.....	1	1	32	1
1873	14	12	1	2	13	.....	1	4	47	3
1874	7	(1) 12	1	.....	9	2	1	5	(1) 37	2
18.5	8	(2) 13	2	.....	9	2	3	4	(2) 41	2
1876	(1) 10	(1) 12	2	1	11	(1) 5	1	5	(3) 47	3
1877	3	(1) 4	1	.....	4	1	.....	(1) 2	(2) 15	1
1878	(1) 6	11	2	.....	(1) 4	4	2	(1) 2	(3) 31	2
1879	(1) 8	13	.....	2	10	3	6	(1) 1	(2) 43	2
1880	(1) 6	8	2	1	6	4	5	5	(1) 39	(1) 2
1881	(1) 8	10	2	1	7	6	4	2	(1) 40	2
1882	(3) 9	(6) 14	4	.....	(1) 21	13	9	8	(10) 79	4
1883	(1) 9	(3) 22	2	2	15	19	14	4	(4) 87	4
1884	(1) 21	(3) 23	1	1	18	20	16	6	(4) 106	(1) 4
1885	(3) 16	(1) 24	5	1	24	9	12	3	(4) 94	.....
1886	(2) 16	(2) 28	7	6	(1) 35	22	11	5	(5) 130	4
1887	(6) 24	(1) 33	8	4	(1) 32	39	14	10	(8) 164	6
1888	(2) 20	(3) 28	17	18	64	62	(1) 29	21	(6) 259	(1) 11
Unknown.	8	(2) 15	2	1	2	8	4	4	(2) 44	3
Total	(32)254	(27)406	73	55	(4)325	(1)224	(1)135	(3)126	(68)1598	(3) 68

Subsidiary water-works, viz.: those which derive their supply from the mains of some other adjacent works, but are otherwise independent systems are enumerated above in parentheses. There are but 4 in the North Central States.

Canada in this and the following tables includes 3 Newfoundland Works.

TABLE 2-S.

UNITED STATES AND CANADIAN WATER-WORKS — SUMMARY OF CONSTRUCTION BY STATES AND HALF DECADES.

[Date given is that of completion of works.]

DATE.	N. E.	Mid.	So. A.	So. C.	No. C.	N. W.	S. W.	Pac.	Total U. S.	Canada.
Before 1830	1	3	1	.....	.....	.....	.....	.....	5	.....
1801-10	2	6	.....	.....	.....	.....	.....	.....	8	1
1811-20	2	1	.....	.....	1	.....	.....	.....	4	.....
1821-30	1	5	3	1	1	.....	1	1	13	.....
18 1-40	3	3	3	6	3	.....	.....	1	19	1
1841-50	3	12	1	1	2	.....	.....	.....	19	4
1851-55	(1) 8	14	1	.....	.....	.....	.....	2	(1) 25	1
1856-60	(1) 6	(1) 19	3	1	3	.....	.....	4	(2) 36	3
1861-65	6	5	.....	1	1	.....	.....	10	23	1
1866-70	(6) 20	28	.....	3	16	3	.....	9	(6) 79	1
1871-75	(1) 38	(3) 65	6	4	44	6	7	21	(4) 191	8
1876-80	(4) 33	(2) 48	7	4	(1) 35	(1) 17	14	(3) 15	(11) 173	(1) 10
1881-85	(9) 61	(13) 93	14	5	(1) 86	67	55	23	(23) 406	(1) 14
1886 88	(10) 60	(6) 94	31	28	(2) 131	123	(1) 84	16	(19) 353	(1) 21
Unknown.	8	(2) 15	2	1	2	8	4	4	(2) 44	3
Total.	(32) 254	(27) 406	73	55	(4) 325	(1) 224	(1) 135	(3) 126	(68) 1598	(3) 68

TABLE 4 S.

UNITED STATES AND CANADIAN WATER WORKS — SUMMARY BY STATES OF THE MAIN STATISTICS GIVEN IN TABLE 3-E.

GROUP.	Pop'n on Water-Works 1880 census.	No. of works.	Present Finances.		Miles of Mains.	Number of		
			Cost.	Revenue.		Taps.	Hydrants.	Meters
New England	2,409,359	(32) 254	$4,992,72	6,411,624	5,291	313,4 4	32,300	37,913
Middle	6,165,618	(27 406	155,5 2,264	15,025,661	7,424	590,02	56,496	34,346
So. Atlant c	533,069	73	9,781,982	1,918,582	747	48, 34	5,249	2,889
So. Central	634,280	55	18 143,721	1,472,548	856	50,302	6,871	2,365
No. Central	3,010,732	(4) 325	69,400,428	6 758,6 9	5,037	352, 63	40,546	12,085
Northw'n	672, 33	(1) 225	22 596 732	2,104,645	1,43	55 538	11 411	3,447
Southw'n.	8 3,471	(2) 13	32,284,437	2,98 ,8 3	1,498	89,756	10,992	4,425
Pacific	5 6,041	(2) 1.6	38,450,237	3.5.5,759	1.9 2	87 926	5,047	9,945
Total U. S	14 637,612	(68) 1 98	431,225,546	39,363,281	24,257	2089,544	168,511	107,415
Canada	737,0 3	(3) 68	21,313 869	1,955,069	1,371	172 947	9,314	2,077

TABLE 5-S.

UNITED STATES WATER-WORKS.—SUMMARY BY DATES OF FIRST CONSTRUCTION OF THE MAIN STATISTICS OF ALL UNITED STATES WATER-WORKS.

DATE.	Present pop'n of water-works.	No. of works.	Present Finances.		Miles of Mains.	Number of		
			Cost.	Revenue.		Taps.	Hydr'ts.	Meters.
1798-1850	5,445,846	69	148 872,872	13,246,050	5,213 64	833,106	46,257	31,873
51-60	2,318,648	(3) 6	75,569,799	6,833,464	3,027,2	302,846	19,97	23,5 9
61-70	1,252,081	(6) 102	35,403,314	3,477,131	2,67 0 1	163,783	15 712	4,752
71-80	2,881,478	(3) 354	88,932,463	7,890,267	5,962,02	345, 17	37,745	37,2 8
81-85	1,640,049	(22) 418	43,586,712	4,195,590	3,861 35	159,978	24 770	8,3:2
86- 8	1,260,032	(16) 465	39,358,886	3,645,699	3,447 73	80,615	23,565	1,514
Unknown.	59,478	(4) 34	641,500	68,090	73.80	3,269	492	12
Total.	14,637,612	(64) 1603	432,225,546	39,356,261	24,256.68	1,888,744	168,511	107,260

N. B.—This table does *not* represent the status of the works at the several dates (except as to number) but the statistics of the *current year* 1888, of works *first opened* at the several dates.

TABLE 6—S.

UNITED STATES AND CANADA.—POPULATION STATISTICS IN RESPECT TO WATER-WORKS.

[The "town population" is in towns of 4,000 inhabitants or over.]

STATES.	Total Population.			Urban Popn't'n 1880.	Per cent. of total.	Pop'n on Water-works, 1888.			Av. pop'n on each water-works.
	1870	1880	Inc. per cent.			Total by 1880 Census.	P. C. of		
							Total pop'n.	Urban p'p'n.	
New England	3,487,924	4,010,529	15.0	,999,339	49.6	2,469,359	59.8	120.6	8,391
Middle	9,8 8,4 5	11,756,053	19 4	,538,720	47.2	6,165,618	52.5	113.1	14,231
So. Atlantic	4,816,4 1	6,338,09 2	31.6	475,660	7.5	5,36,069	8.5	112.7	7,330
So. Central	5,131,360	6,525,497	27.2	654,355	10.2	684,289	10.5	103.0	12,400
No. Central	9,124,517	11,206,668	22.8	2,689,7 7	24.0	3,010,732	26.9	111.9	9,140
Northwestern	2,165,012	4,049,011	87.1	468,153	11.5	672,033	16 6	143.5	2 980
Southwestern	3,156,83	4,876 546	54.5	7 0,787	14.4	843,471	17.3	120.4	6,190
Pacific	829,059	1,393 857	68.2	419,309	30.1	536,041	38.4	127.9	4,1 0
Total U. S.	38 558,371	50,155,783	30.1	12,936,110	25.7	14,857,612	29.6	114.9	8,900
Canada	3,635,034	4,324,810	17.2	723,340	16.7	706,273	16.3	97.6	10,350
Newfoundland	161,374	185,000	14.6	27,770	15.0	30,770	16.6	110.8	

The Canadian population is for 1871 and 1881, and the Newfoundland population for 1874 and 1883, the latter estimated.

TABLE 7 S.

UNITED STATES AND CANADA — CLASSIFICATION OF WATER-WORKS BY SIZE OF TOWN IN 1880.

GROUP.	1,000 or under.	1,000 to 3,000	3,000 to 5,000	5,000 to 10,000	10,000 to 20,000	20,000 or over.	Total No.
New England	40	80	65	48	35	19	287
Middle	47	174	78	78	24	32	433
So. Atlantic	13	25	7	11	7	8	71
So. Central	8	14	7	11	4	7	51
No. Central	35	102	68	67	36	17	325
Northwestern	94	79	23	14	9	6	225
Southwestern	47	40	25	10	6	6	134
Pacific	52	46	12	5	4	4	123
Total U. S	336	560	285	244	125	99	1,649
Canada	9	14	15	19	3	8	68

TABLE 8-S.

UNITED STATES AND CANADIAN WATER-WORKS.—COST AND REVENUE PER HEAD, TAP, MILE OF MAIN, ETC.

GROUP.	Cost per			Revenue per			Population on water works.		P. C. rev. to cost.
	head on water-works.	mile of main.	tap.	head on w'ter w'ks.	mile of main.	tap.	per tap.	per meter.	
New England	$35 20	$ 6 800	$389	$2.66	$1 03	$20.30	7.6	63 4	7.54
Middle	25.40	21,000	176	2.43	2,023	16.90	6.9	181	9.40
So. Atlantic	18.25	13,070	202	1.90	1,362	21 00	11.1	174	10.40
So. Central	26.80	20,050	300	2.15	1,678	29.20	13.4	2 9	8.13
No. Central	23. 0	13,780	197	2-24	1,328	19.18	8.5	230	9.72
Northwestern	33.60	15,660	406	3.13	1,461	37.90	12.1	195	9 31
Southwestern	38.25	21,580	2 0	3.55	2,000	33.25	9 4	190	9.29
Pacific	71.80	19,800	8 8	6.18	1,838	40.70	6.1	54	9.29
Total U. S	29.15	17,800	207	2.65	1,620	18.80	7.11	138½	9.11
Canada	23.90	15,560	123	2.65	1,426	11.30	4.25	354	9.16

we say that it is about one fiftieth part of that falling over Niagara Falls; while the average height to which it is pumped is fully 120 ft., or more than three fourths the height of the cataract. Only from one-half to two-thirds of this pumping capacity, however, is in daily use.

[For lack of space we postpone until our following issue the concluding Tables accompanying this article, and referred to in our text.]

Abstract of the President's Address at the Louisville Meeting of the American Water-Works Association.

Mr. A. N. DENMAN, President of the Association, commenced his address by noting that that body had now reached its ninth anniversary, a period at which, in the history of mankind, we can usually presage the character of the future man. So with the Association of American Water-Works, which the President believed had already proven, by its record of work performed at this comparatively early stage of its existence, that it had come to stay, that its influence was already felt in the improved character of the works in the cities under the control of its members, in better machinery and better methods, and in the increased purity of the water furnished to consumers.

Mr. DENMAN warmly advocated united action among the members, and vigorous efforts to still further improve upon the good record made, so that the Association by its high character would so establish itself in the confidence of the people as to be always regarded as a safe counsellor and a just arbitrator in all differences.

He remarked that in this day of trusts and corporations, it is important that the public should not get the two confounded; and the speaker then proceeded to define the two as they might pertain to water-works.

The private vs. municipal ownership of water-works in cities was next touched upon as a subject proper for discussion among bodies similar to the association over which the speaker presided. Mr. DENMAN said that in discussing this question writers for and against private ownership seemed to forget that in either case the works were controlled by men of like passions, and he failed to see how, with fair and honest treatment, a private corporation could be in any way inferior to city ownership so far as the conduct of the works was concerned.

Mr. DENMAN made the telling point that any city government so weak or so corrupt as to delegate its powers to a water company, without at the same time passing restraining laws, and insisting upon their fulfilment, was certainly not fitted to conduct the affairs of the enterprise individually. A water company is a quasi public corporation in any case, and is, or should be, governed by its charter in every detail of its business, except that it may make such ordinary and reasonable rules for the conduct of its affairs as are not inconsistent with an honest purpose and accord with the usual laws of trade. The speaker thought that an honest public would eventually secure the honest management of a private corporation, and he further expressed the opinion that municipal corporations and the public were chiefly responsible for the faults of private corporations, where these faults existed.

The president then showed, by apt quotations from legal decisions, that the term "pure water," taken in its absolute sense, is absurd. Water is a wonderful solvent, and can neither pass over the earth nor through the atmosphere without contracting impurities. Even comparatively pure water is difficult to obtain in large quantities, for in populous sections of the country, where water is most needed, neither the rivers nor smaller streams can be kept entirely clear of sewage. Melting snow contaminates them and rains fill them with mud; and mountain streams and even springs that flow from the rock are not always free from pollution of some kind. Chief Justice GORDON, of the Pennsylvania Supreme Court, defines "pure water," as it stands in the Act of Assembly of that State, as "wholesome, ordinarily pure," and says that it is an expression that must be used as used by the world at large, and not in its abstract or chemical sense.

The president referred at some length to other legal decisions relating to the rights of water companies, the quality of the supply furnished, the exclusive privilege of the first company, fire-hydrants, etc. He concluded his address by a brief review of the character of the papers to be read before the association, and with a friendly greeting to the new contributors of papers.

THE BELKNAP WATER MOTOR, elsewhere illustrated and described, looks like a very promising novelty, and especially so in its application to a dynamo for minor lighting purposes. Water power conveyed through pipes is nearly always available, and with this inexpensive motor can be made useful in very many ways; but for dynamos requiring from 5 to 8 H. P., it seems peculiarly well adapted for use in many localities.

CORRESPONDENCE.

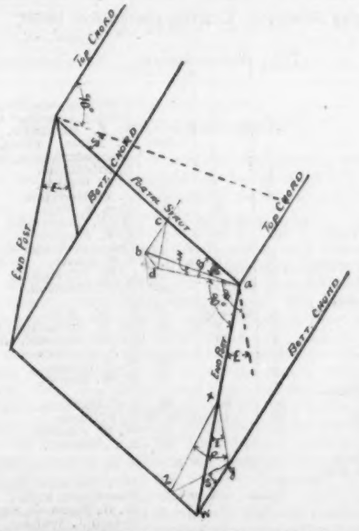
Computing the Bevel Angles for Skew Portals.

EDGE MOOR, Pa., April 15, 1889.

TO THE EDITOR OF ENGINEERING NEWS:—

Having occasion to figure the various bevel angles required in laying out a skew portal, we have devised the following formulæ, which save much tedious figuring as compared with the methods previously in use here and in other bridge offices. Thinking they may be of use to others, we offer them to you.

The angles usually required are the ones which we have designated as *B*, *H*, and *P* in the accompanying cut. *B* is the amount which the bracket angle differs from 90°. *H* is the amount by which the angle between the plane of the portal and the plane of the truss differs from 90°, and gives the bevel for bending the hitch plates on brackets. *P* is the angle between the plane of



Computing Bevel Angles for Skew Portals.

the portal and a vertical plane through the center line of the portal strut, and gives the bevel for bending the hitch-plate to connect with top chords.

By the angle between two planes we mean, of course the angle cut out by another plane at right angles to the intersection of the two. These angles are evidently functions of the skew angle *S*, and the angle of the end post with the vertical *E*, and it is only necessary to determine what functions. The formulæ are:

$$\tan H = \tan S \cos E$$
$$\sin B = \sin S \sin E$$
$$\tan P = \tan E \cos S$$

The demonstration we send is hardly necessary, but may be required perhaps to convince some that there is a way so much shorter than the roundabout methods in general use. Yours truly,

M. J. PATTERSON.

DEMONSTRATION.

Skew angle *S* and angle of end post with vertical *E* are known. To find first angles *H* and *B*.

Through *a*, pass line *a b* perpendicular to plane of truss and 1 unit long. Through *b* pass a plane parallel to plane of truss, cutting line *b c* out of plane of top chords and *c d* out of plane of portal. Through line *a b* pass a plane perpendicular to direction of end post. We thus form the pyramid *a-bcd* about which the following things are true.

$$\left.\begin{matrix} a\,b\,c \\ a\,d\,c \\ a\,b\,d \\ b\,d\,c \end{matrix}\right\} = 90° \qquad \begin{matrix} a\,c = Sec\ S \\ c\,b = Tan\ S \\ b\,d = Tan\ H \end{matrix}$$

$$\begin{matrix} b\,a\,c = S \\ c\,b\,d = E \\ c\,a\,d = B \\ b\,a\,d = H \end{matrix}$$

Draw out small triangle *b d c* by itself, and we see that $\tan H = \tan S \cos E$.

Draw out triangle *a c d* by itself, and we see that $c\,d = \tan S \sin E$. Therefore:

$$Sin\ B = \frac{c\,d}{a\,c} = \frac{\tan S \sin E}{\sec S} = \sin S \sin E$$

2. To find angle *P*.

From *x* drop the perpendicular *x y* 1 unit long, from *y* lay off line *y z* in plane of floor-making angle *s* with *y w*. Connect *x z*.

Then $y\,z\,w = 90°$, $w\,x\,y = E$, $z\,x\,y = P$.

$\tan P = y\,z = \tan E \cos S$.

Iron and Steel Compound Bridge Pins.

MONT CLARE, Pa., April 19, 1889.

TO THE EDITOR OF ENGINEERING NEWS:—

Doubtless many of your readers will be interested in the following notes:

On Sept. 9, 1881, I made some full size tests of combination (iron and steel) bridge pins for the Albany and Greenbush bridge, Mr. A. P. BOLLER, Chief Engineer.

The pile for rolling was made of old Bessemer steel rails, rolled nearly flat, cut into short lengths, and enclosed with four wrought-iron plates, the finished bar having a heart of steel and an envelope of double refined-iron, the latter varying in thickness from ⅝ to ¾ of an inch.

The tests were made at the Phœnix Iron Works, Phœnixville, Pa., on a lever machine, 1-20, the pin being held by an eye-bar at each end and broken by a third eye bar at the middle.

Pin No. 1, 4⅛ ins. diameter, 28 ins. long, bent slightly, while strained at 37,700 lbs. on extreme fibers, took a permanent set at 56,000, and broke, on the nineteenth test, at 92,000 lbs. on extreme fibers, having deflected ⅝ in. on the eighteenth test.

Pin No. 3, 4⅛ ins. diameter, 24 ins. long, had no perceptible bend at 38,900; permanent set took place at 49,000, and it broke at 145,000 lbs. on extreme fibers. The deflection on the twenty-third test—next to last—was 1 in.

Pin No. 2 gave results very similar to No. 1. In every case the fracture showed a perfect union of the two metals.

No. 3 was peculiarly interesting because of the fact that while it was being cut from the rough bar in a lathe, with a square-nosed tool, its own weight overhanging the tool caused it to break off when the body in the cut was 2⅝ ins. diameter, creating the impression that the material in this bar was defective, for pins ordinarily do not drop until the neck is reduced to 1 in. or less. The test, however, indicated that, instead of being stiff and brittle, the bar was soft and tough.

Subsequently I broke a double refined iron pin under the same conditions, and found the elastic limit lower than No. 1, but higher than No. 3, and the ultimate somewhat lower than No. 1. Respectfully,

HENRY H. QUIMBY.

Notes, Queries and Answers.

J. B. N., Norwalk, O. (1) The ink referred to for graduating brass tapes is the bichloride of platinum, and you should be able to get it from any good druggist, or he can secure it for you. (2) To make application for admission to the Am. Soc. C. E., send to JOHN BOGART, Secretary, 127 E. 23d St., New York, for blank forms and requisites for membership.

B. C. B., Colima, Mex. The method of computing tables by constant differences and repeating terminal figures, which you have (re)discovered, is almost as old as mathematics, and is used for computing all tables having ultimate constant differences. The use or non-use of decimals has nothing to do with it. See any table of squares. The last digit repeats itself in series of 10, the last two in series of 50 (running each way from the middle 25 point) and so on for any number of digits, and for all kinds of tables which have 2d, 3d, or 16th differences constant. The whole thing has been reduced to a science long since, and books and articles without number written on it. Our view on a metric field-book has been recently expressed editorially.

FREEZING POINT OF MIXTURES OF GLYCERINE AND WATER.—*Le Moniteur des Produits Chemiques* gives the following table of the freezing points of mixtures of water and glycerine:

Freezing Temperatures. Cent.	*Glycerine. Parts.*	*Water. Parts.*
0	0	100
— 1.56	10	90
—12.50	36	64
—12.65	46	54
—29.73	58	42
Below —35.07	70	30

Elements of Weather in the United States of most Interest to Engineers, for the Month of March, 1889.

STATIONS.	Temperature. Degrees Fah.				Wind velocity. Miles per hour.			Precipitation. Rain and melted snow. Inches.		
	Average	Max.	Min.	Range.	Average.	Max.	Direction at time of Max. Vel.	Total.	Heaviest in 24 hours.	No. rainy days.
Northern Cities.										
Northfield, Vt.	28.4	55	8	47	8.3	45	N	2.05	0.72	11
Portland, Me.	34.0	60	16	44	9.2	32	NE	2.68	0.89	11
New York City	39.9	62	25	37	12.1	49	SW	4.09	1.38	11
Pittsburg, Pa.	41.4	70	23	47	5.0	36	W	2.32	0.96	15
Chicago, Ill.	36.8	68	20	48	10.7	40	N	1.43	0.93	5
Omaha, Neb.	40.2	71	17	54	8.1	30	N	0.53	0.32	4
St. Paul, Minn.	34.4	67	13	54	7.0	30	NW	0.90	0.35	6
Duluth, Minn.	32.0	64	1	63	7.9	30	NE	1.67	0.65	10
Bismarck, Dak.	33.8	69	4	65	7.5	48	NW	0.55	0.42	9
Average	35.6	65.1	14.1	51	8.4	38		1.81	0.74	9.1
Southern Cities.										
Washington City	42.0	70	29	41	8.0	30	NE	4.20	1.45	14
Louisville, Ky.	47.2	76.0	24.0	52.0	6.9	40	SW	0.95	0.34	8
St. Louis, Mo.	44.8	76.0	25.0	51.0	11.0	36	NE	1.62	0.73	4
Savannah, Ga.	53.9	77.0	34.0	43.0	7.4	46	NW	3.52	1.34	9
Leavenworth, Kan.	48.2	72.0	21.0	51.0	6.4	30	S	1.32	0.67	6
Jacksonville, Fla.	57.1	81	39	42	6.1	28	W & NW	1.38	0.39	8
Chattanooga, Tenn.	50.2	80	26	54	6.2	26	NW	3.71	1.64	7
New Orleans, La.	58.5	79	44	35	9.0	35	SW	3.86	1.39	5
Memphis, Tenn.	52.0	80	33	47	6.2	30	W	5.33	1.33	14
Palestine, Tex.	57.2	82	38	44	6.9	27	NW	4.53	1.67	9
Average	50.6	77.3	31.3	46.0	7.4	32.8		3.04	1.10	8.4
Western Cities.										
Helena, Mont.	38.2	64	4	60	5.3	29	NE	0.64	0.22	7
Port Angeles, Wash.	45.6	59	30	29	2.0	24	W	2.43	0.56	15
San Francisco, Cal.	55.6	79	47	32	8.7	32	NE	7.78	3.08	16
Salt Lake City, Utah	48.0	68	32	36	5.6	34	SE	1.64	0.60	8
Denver, Col.	41.6	70	18	52	6.7	36	N	0.40	0.34	4
Yuma, Ariz.	65.9	90	44	46	6.3	40	W	0.24	0.15	4
Santa Fé, N. Mex.	39.6	66	20	46	6.7	36	S	0.80	0.30	11
Average	47.8	71	28	43	5.9	33		1.99	0.75	9.3

Extensions and Additions to Water-Works Systems Contemplated for 1889.

City or Town.	*Pipe.*	*Hydrants.*	*Valves.*	*Meters.*	*Address.*
Brunswick, Me.	3,000 ft. ¾-in. services				I. H. Simpson, Supt
Bristol, N.H.	1,000 ft. 4-in	2 or 3	2		Bristol Aqueduct Co
Keene, "	2,200 ft. 12-in.—1,100 ft. 8-in	7	6		P. F. Babbidge, Supt.
Laconia, "	1,000 ft. 6-in.—3,000 ft. services	3		200	E. Little, Treas.
St. Albans, Vt.	1,000 ft. 4-in	2	2		Marshall Mason, Supt.
W. Randolph, Vt.	2,640 ft. 4, 2, and 1-in	1	1		L. Richmond, "
Adams, Mass.	3,000 ft.	6	4		C. A. Waters, "
Arlington, "	1,000 ft. 4-in	4	2		r. W. Hodgdon, "
Attleboro, "	3,000 to 4,000 ft. 4 and 6-in	6	10	20	Geo. B. Fitts, Supt.
Brookton, "	6,000 ft. 6-in.—3,000 ft. 10-in.	10 or 12	10 or 12	150	W. F. Cleaveland, "
Brookline, "	4,000 ft. 6-in.—1,000 ft. 2-in	15	20	50	F. F. Forbes, "
Chicopee, "	1,000 ft.2-in				Chicopee Water Co.
Grafton, "	3,000 ft. 6-in	1	3		S. F. Smith, Supt.
Hingham, "	2,000 ft. 4-in	6	3		C. W. Seymour, "
Hudson, "	5,500 ft. 6-in	8	17		D. W. Stratton. "
Malden, "	2,640 ft. 12-in.—2,640 ft. 10-in. 2,640 ft. 8-in 2,640 ft. 6-in.	6	40 or 50	2	S. M. Allis, "
Mansfield, "	3,520 ft. 4-in.—1,760 ft. 6-in	8	6	10	D. D. Spaulding, Chn.
Plymouth, "	600 ft. 6-in.—1,300 ft. 4-in	4	15		R. W. Bagnall, Supt.
Randolph, "	10,560 ft. mostly 6-in	15	5		E. J. Chadbourne, "
Rockland, "	6,000 ft. 6-in	5	4	10	W. R. Groce, "
Salem, "	2,000 ft. 6-in.—2,000 ft.4-in	7	8	8	H. W. Rogers, "
Springfield, "	3,400 ft. 16-in.—1,860 ft. 12-in.—2,200 ft. 8-in.—25,000 ft. 6-in.—1,500 ft. 4-in	45	66	75	J. C. Hancock, "
Taunton, "	3,000 ft. 8-in.—7,200 ft. 6-in.—1,600 ft. 4-in.	12	12	60 or 70	G. F. Chase, "
Wellesley, "	1,000 ft. 10-in.—4,280 ft. 6-in.	10	8	10	W. H. Vaughn, "
Whitman, "				25	J. C. Gilbert, "
Providence, R. I.	5,734 ft. 24-in.—19,66 ft. 20-in.—172 ft. 16-in.—3,252 ft. 12-in.—7,743 ft. 8-in.—19,066 ft. 6-in.	Unknown			S. M. Gray, City Engr.
Danbury, Conn.	15,840 ft. 10-in.—30,960 ft. 6 in	50		20	N. T. Bulklev, Secy.
Hartford, "	13,200 ft. 6-in	Unknown			Ezra Clark, Prest.
New London, "	11,400 ft. 20-in.—8,800 ft. other sizes	"	"	"	W. H. Richards, Supt.
Waterbury, "	3,000 ft. 8-in.—400 ft. 6-in.—5,000 ft. 4-in	"	"	"	Nelson J. Welton.
Albany, N. Y.	20, 16, 12, 8 and 6-in. amount unknown.	"	"	"	G. W. Carpenter, Supt.
Amsterdam, "	500 ft. 8-in.—3,000 ft. 6-in	8	5	10	A. H. DeGraff, "
Attica, "	2,500 ft. 4-in	3	2	2	Attica Water Co.
Auburn, "	8,000 ft. 6-in	10	10	100	H. B. Eldred, Supt.
Ballston Spa, "	800 ft. 4-in.—1,000 ft. 3-in	8	10		J. H. Norris, "
Binghamton, "	2,361 ft. 8-in.—10,500 ft. 6-in.—2,500 ft. 4-in.	25	35	15 or 20	D. Felter, "
Buffalo, "	132,000 ft. 36 to 5-in	250	200		L. Knapp, "
Cornins, "	1,300 ft. 6-in	4	3		H. C. Heermans, "
Dunkirk, "	2,640 ft. 4 and 6-in	4	6		G. M. Abell, "
Herkimer, "	600 ft. 4-in	1	1		C. C. Spinner, Secy.
Hudson, "				1 or more	P. Miller, "
Johnstown, "	3,400 ft. 6-in.—3,450 ft. 4-in	13	7	Unk'n	J. J. Buchanan, Supt.
Kingston, "	2,500 ft. 6-in.—5,500 ft. 4-in	17	3 or 4		C. D. Bruyn, Secy.
Newburgh, "	3,600 ft. 6-in. 400 ft. 4-in	10	15		W. C. Miller, Supt.
Poughkeepsie, "	1,000 ft. 6-in	5	4	125	C. E. Fowler, "
Round Lake, "		5	1		J. D. Rogers, "
Rome, "	7,000 ft. 6-in	5	6		C. T. Hayden, "
Schenectady, "	4,650 ft. 8-in.—2,000 ft. 4-in.	20	40		M. O. Caldwell, "
Troy, "	8,000 or 10,000 ft.	25 to 50	30 to 60	"All we can."	P. H. Baermann, "
Walton, "	1,500 ft. 4-in	3	1		S. Comstock, Prest.
Westfield, "	31,680 ft. 12 in., etc	25	10		F. B. Brewer.
Whitehall, "	1,000 ft. 6 and 4-in	3			C. M. Hotchkiss, Supt.
Asbury Park, N. J.	2,600 ft. 8-in			20	G. H. Coffin, "
Jersey City, "	26,400 ft. mostly 6-in	90 to 100	60 to 70	Unk'n.	W. W. Ruggles, Engr.
Newark, "	30,000 ft. 6-in	50	150	50	G. R. Gray, Supt.
Paterson, "	21,120 ft. 6-in.—2,640 ft. 8-in.—2,640 ft. 24-in.	50	100		W. Ryle, "
Allegheny, Pa.	5,280 ft. 12-in—10,560 ft. 10 in.—36,960 ft. 8-in.—36,960 ft. 6-in	200	818		E. Armstrong, "
Erie, "	2,640 ft. 30-in.—13,200 ft. 6-in.—5,280 ft. 4-in.	10	25	Unk'n.	B. F. Sloan, Secy.
Sayre, "	5,000 ft. 6-in.—5,000 ft. 4-in				Sayre Water Co.
Shippensburgh, "	1,000 ft. 4-in	2			B. F. Landis, Supt.
Bellaire, O.	1,000 ft. 12-in.—1,000 ft. other	4	3		H. G. Wilson, "
Springfield, "	4,627 ft. 6-in.—3,877 ft. 3-in	10	13	5	W. R. Smith, "
Toledo, "	15,840 ft. 12-in.—1,160 ft. 6-in.—5,280 ft. 8-in.	20	40	25	H. C. Cotter, "
So. Bend, Ind	New boilers, etc. to be added			12	I. S. Schrop, "

PERSONAL.

Mr. T. W. DAVENPORT has been appointed Superintendent of Streets, at Lockport, N. Y.

Mr. W. S. PALMER has been appointed Chief Engineer of the Petaluma & Sebastopol road.

Mr. D. C. CREGIER, M. E., has been elected mayor of Chicago, Ill.

Mr. C. W. CROZIER has been appointed City Engineer of West Knoxville, Tenn.

Mr. M. H. SMITH, Vice-President of the Louisville & Nashville, has resigned.

Mr. THOS. R. WICKENDEN has been re-appointed City Engineer of Toledo, O.

Mr. DAVID A. GAGE, who was Superintendent of the Cheshire railway from 1850 to 1853, died at his home at Charlestown, N. H., April 11.

Mr. CHARLES BRYAN has been appointed Superintendent of Water-Works at Parkersburg, W. Va. Mr. DAVIS DUNCAN has been appointed Street Commissioner.

Col. EDWARD P. NETTLETON, at one time counsel of the New York & New England road, died at Boston Mass., April 17.

Mr. JAMES BRAND, Commission Merchant, will remove May 1 to the Market & Fulton National Bank Building, 81 and 83 Fulton St., N. Y.

Mr. ALBERT D. WATROUS has been appointed Superintendent for the Mystic Valley Water Co., of Stonington, Conn.

Mr. C. V. SHINKLE has been appointed Contracting Agent of the Southern Pacific, with headquarters in this city, succeeding W. H. CONNOR.

Mr. S. T. MANN, formerly on the engineer's staff of the Louisville, Evansville & St. Louis, has taken a position on the Georgia Central.

Mr. HENRY D. WELSH has been elected President of the Allegheny Valley road to succeed Hon. JOHN SCOTT.

Mr. EDWARD DICKINSON has been elected President of the Idaho Central road. He will not, however, relinquish his Union Pacific position.

Mr. J. F. WALLACE, M. Am. Soc. C. E., formerly Bridge Engineer on the Chicago, Santa Fé & California R. R., is now with Mr. E. L. CORTHELL, Consulting Engineer, 205 La Salle, Street, Chicago, Ill.

Lieut. L. D. MINER, U. S. N., has been chosen by the Regents of the University of Michigan to be Assistant Professor of Mechanical Engineering of that Institution.

Mr. J. C. EASTON, of La Crosse, it is reported, has tendered his resignation as a director of the Chicago, Milwaukee & St. Paul road. Mr. EASTON has been a director of the road for 10 years.

Mr. W. W. FINLEY, General Freight Agent of the Denver Texas & Gulf R. R., has been elected Chairman of the Trans-Missouri division of the Interstate Railway Association.

GENERAL PASSENGER AGENT BOYD, of the Minneapolis & St. Louis Railroad, has been appointed to the same position in charge of the Chicago, Kansas & Nebraska division of the Rock Island system. He will be succeeded by Mr. C. H. HOLDRIDGE.

Mr. GEO. W. MASLIN has resigned his position in the office of the First Vice-President of the Baltimore & Ohio, to become the Superintendent of the Roanoke & Southern road.

Mr. DANIEL ULRICH, late Assistant Engineer on the Erie R. R. at Buffalo, N. Y., has resigned his position to associate himself in business with Mr. GEO. A. RICKER, a civil engineer of that city.

Mr. LUCIUS TUTTLE, Passenger Traffic Manager of the Canadian Pacific, will probably be selected to succeed Mr. PIERSON as Vice-Chairman of the Trunk Line Association, New York.

Col. JACOB M. LONG, who built the water-works at Pottsville, Pa., and the gas works at Harlem, N. Y., of which latter works he was for some time Superintendent, died in New York, April 16.

Mr. A. BUTTS, Purchasing Agent of the Louisville, New Albany & Chicago road, has resigned to accept a position in a railway supply house at St. Louisville. He is succeeded on the L. N. A. & C. road by his brother, Mr. F. C. BUTTS.

Mr. L. M. HASTINGS has been appointed City Engineer of Cambridge, Mass., succeeding Mr. WM. S. BARBOUR, deceased. Mr. HASTINGS has been in the City Engineer's office for the last 18 years, and has for some time been principal assistant.

Mr. H. A. PARKER has been appointed assistant to the President of the Rock Island road, with an office in Chicago. Mr. PARKER was General Manager of the Chicago, Kansas & Nebraska, until it was decided to place the entire system under one management.

Mr. ROBERT MOORE, C. E., of St. Louis, lately at the Bridge Entrance, has established his office as Chief Engineer of the St. Louis Merchants' Bridge Terminal Railway. Letters should be addressed to ROBERT MOORE, Chief Engineer Terminal Ry., Laclede Building, St. Louis, Mo.

Mr. H. F. CLARK has been selected to succeed the late W. W. WELLS as Superintendent of the Cincinnati, New Orleans & Texas Pacific Division of the Queen & Crescent system. Mr. CLARK is at present Superintendent of the Vicksburg & Meridian, and Vicksburg Shreveport & Pacific Divisions of the Queen & Crescent.

Mr. C. J. SMITH has been appointed General Manager of the Oregon Railway & Navigation Company in place of W. H. HOLCOMB. The appointment will take effect May 1. Mr. SMITH was in the Land Commissioner's Department of the Union Pacific at Omaha. His office will be at Portland, Ore.

Mr. E. H. BECKLER, in addition to his duties as Chief Engineer of the Montana Central Ry., has been appointed Superintendent of the road with headquarters at Helena, Mont. He will have charge of station and transportation service, and maintenance of road and structures.

Mr. BERT HAZLETT has resigned the position of engineer in charge of the construction of the new high-service reservoir, at Wheeling, W. Va., to which he was recently appointed by the City Water Board. The place was formerly filled by Mr. WALTER SMITH, but he was obliged to resign in order to properly look after county work.

Col. CHARLES F. HATCH, President of the Wisconsin, Minnesota & Pacific Ry., died at Minneapolis, Minn., April 15. He was about 60 years of age and had always been actively identified with railway business. He first came into prominence as General Superintendent of the Lake Shore & Michigan Southern, and after a few years resigned to serve in a like capacity with the Eastern Railroad of Massachusetts. After two years he returned to the Lake Shore road. In 1877 he was the unanimous choice of the directors of the Minneapolis & St. Louis for General Superintendent of that line, and went to Minneapolis. The following year he was made General Manager, and in 1882 resigned to become General Superintendent of the Omaha, and when the extension of the St. Louis into Dakota was projected, under the title of the Wisconsin, Minnesota & Pacific, he became its President, and has been with the line ever since.

PUBLICATIONS RECEIVED.

—*Steam: Its Generation and Use.* With Catalogue of the Babcock Wilcox Co., 30 Cortlandt St., New York City. Cloth, 120 pp.

The present tendency in getting up trade catalogues is towards very elaborate material and style, and this catalogue, the edition for 1889, is very well got up, and is interesting reading. The reading matter, after showing the danger and the causes of boiler explosions, and the importance of providing against explosions, contains papers on "The Theory of Steam Making" and "The Theory of Heat Engines." A brief illustrated history of water-tube boilers leads up to the evolution of the Babcock & Wilcox water-tube boiler, and this matter is very fully illustrated; the boiler is described and illustrated in detail. Brick and iron chimneys, heating for central stations, steam heating, wet and superheated steam, are subjects dealt with. The reading matter covers 80 pages, 16 pages are devoted to accounts of tests, etc., 20 more are filled with home and foreign references, and the index fills the last four. The book is very fully illustrated, nicely printed on good paper, well bound, and lettered on the back. It shows the enterprise of the Babcock & Wilcox Co. in keeping up with the times.

—*Illustrated Catalogue of the Rand Drilling Company.* New York. 1889.—This is a thoroughly good publication of its class. It is, in fact, a hand-book in all that appertains to rock-drills, air-compressors and the handling of drills under the many conditions of rock excavation. Aside from the illustration and concise descriptions of the use and care of the special machines of the Rand Co., this book, of nearly 200 pages, devotes a very considerable space to "Useful Information," relating to compressed-air, steam, transmission of power, sharpening and tempering of drill-steel, measurements of ore and earth, handling rock, etc., etc. The book in its handsome make-up and the care and intelligence evident in its preparation, proves that this company fully understands the art of issuing a catalogue that is at the same time useful to themselves and valuable to every user or prospective user of the machines described.

—*Tube or Pipe Wells, Single or in Gangs.* Pamphlet, 32 pp. Hydraulic Tube-Well Construction Co., 145 Broadway, New York.

This pamphlet is issued by the company to describe and illustrate its system of wells for furnishing a supply of pure water for towns, villages, factories, irrigation works, etc. The system is covered by patents. At the bottom of the pipe is a sand chamber, above which is the strainer, which has countersunk holes covered with finely perforated sheet metal. An improved well-head is used. The system is in use at Syracuse, N. Y., Flushing, N. Y., East New York, N. Y., and Greenwood Cemetery, Brooklyn. The pamphlet contains data respecting thickness of pipe, specific gravities, etc. Mr. F. W. MILLER, hydraulic engineer, is a member of the company.

—*Transactions of the Arkansas Society of Engineers, Architects and Surveyors.* Vol. 2, November, 1888. Published at Little Rock.

In addition to the committee reports, etc., there are the following papers: "Proportionate Error in Surveying," CHAS. W. STEWART; "Climate of Arkansas," W. U. SIMONS; "Public Highways," J. A. MARTIN; "Adaptability of the Various Kinds of Timber in Arkansas for Railway Purposes," E. C. BUCHANAN; "Description for Deeds," WM. MITCHELL; "The Plane Table," D. C. B. AIKEN; "The Construction of Topographic Maps by Reconnoissance Methods," ARTHUR WINSLOW; "Municipal Improvements of Little Rock," G. P. C. RUMBOUGH; "Water Supply of Rogers, Ark." JAY M. WHITHAM.

Catalogue of the Minerals and Woods, from the States of Virginia, North and South Carolina and Georgia, displayed in the exhibits of the Richmond & Danville Railroad Company at Atlanta, 1881; Boston, 1882; Denver, 1883; New Orleans, 1884; Atlanta, 1887; and Richmond, 1889. Pamphlet 34 pp. 5½ x 9 ins. Published by the Richmond & Danville R. R. Co.—This little volume contains some matters of interest with reference to the mineral resources of the region tributary to the Richmond & West Point Terminal Railway system.

—Mr. A. R. FOOTE, the author of a work on the "Economic Value of Electric Light and Power," noticed in our issue of March 30, writes us that we did not fully comprehend his views on the ownership of plant for this purpose. To correct any wrong impression we quote the author's words on this subject as follows:—"The economic value of electric light and power cannot be developed to the point of greatest benefit to the users of electric service by inventors and manufacturers alone. The realization of the advantages of electricity by the people now depends more largely upon the economic conditions fixed for its production and distribution by State and municipal legislation than upon any other factor in the problem. I believe the true functions of government to be to regulate and control, not to own and operate, commercial industries."

SOCIETY PROCEEDINGS.

Engineers' Club of St. Louis.—At the meeting on April 17, the chairman announced the death of Col. HENRY C. MOORE, one of the oldest members and a former president of the club.

Prof. CHARLES C. BROWN'S paper on "The Sanitary Condition of the Water Supply of New York City" was read by Prof. WHEELER. Prof. BROWN, being engineer for the New York State Board of Health, had devoted considerable time and study to the subject. The paper presented a vast amount of data, extending over a series of years, beginning with 1872, showing the results of chemical examinations of Croton water. He also gave a statement of the flow of the Croton river for each year, beginning with 1870, together with the rainfall over the watershed, and the flow of river in percentage of rainfall. He discussed the water under the following heads: Total solids, hardness, albuminoid, ammonia, chlorine, and combined nitrogen. His conclusion was that the case for or against the Croton water, as shown by chemical analysis, had not been proven. He gave the results of a personal examination of the watershed, together with suggestions for treatment of several cases of pollution. He also submitted a copy of the series of rules adopted for the sanitary protection of the Croton river and its tributaries. Messrs. HOLMAN, BRYAN, WHEELER, THACHER, FERGUSON and BOUTON took part in the discussion. Mr. WHEELER stated that there was usually considerable newspaper talk every fall about impurity of the water, but repeated and careful chemical analysis had shown it to be harmless. Mr. BOUTON thought that the marginal zones along the streams were hardly sufficiently wide.

The secretary then read a paper by Mr. A. J. FRITH, describing a system of marking patterns. The question was treated in detail, and the desirable points explained. A sample record sheet was submitted. Mr. FRITH also submitted a brief discussion of economy of manufacture as viewed in the pattern. This question he discussed under the following heads: Economy in the pattern itself; the number and nature of the castings; the subsequent handling of the castings, the object being the minimum cost of the finished product.

In the discussion Mr. CROW spoke of the difficulty of marking small patterns, and also explained the system in use at the Brownell & Wright car shops. Each pattern bore the number of the shop order, and all patterns used on each order were numbered consecutively.

WM. H. BRYAN, *Secretary.*

Boston Society of Civil Engineers.—The regular monthly meeting was held April 17, President DESMOND FITZGERALD in the chair; 47 members and 11 visitors present.

The following were elected as members: WM. C. BOYCE, Worcester, Mass.; EDMUND GROVER, East Walpole, Mass.; FRANCIS E. HOSMER, Boston, Mass., and FRANK B. ROWELL, Lynn, Mass. Mr. THOMAS ASPINWALL was appointed Auditor for the ensuing year, and the membership of the committees on Library and on Weights and Measures was announced. The Secretary was directed by a vote of the Society to keep a record book of addresses of members and others seeking employment.

The Secretary read a memoir of Mr. GEORGE A. PARKER, Honorary Member of the Society, which had been prepared by the late Mr. SAMUEL M. FELTON, also an Honorary Member. Mr. ALBERT H. HOWLAND read a memoir of Mr. EDWARD S. PHILBRICK.

Mr. LAWSON B. BIDWELL read a paper describing the relocation of a portion of the New York & New England Ry., made necessary by the construction of the Sodom reservoir of the new Croton water supply for New York City. He also gave an account of an embankment built through Whaley pond. Mr. SAMUEL M. GRAY, City Engineer, of Providence, R. I., read a paper giving an account of the various sites which have been proposed for terminal facilities in Providence. A general discussion followed this paper, and a vote of thanks was tendered to Mr. GRAY.

At the meeting on May 15, Mr. J. A. GOULD, Jr., will read a paper on "The High Service System of the Boston Water-Works," with particular reference to the new works recently constructed. Mr. C. E. HAERSTROH will read a paper on some recent measurements of flow of water at the Boston water-works.

S. E. TINKHAM, *Secretary.*

American Water-Works Association.—The ninth annual convention was held at Louisville, Ky., April 16, 17, and 18. On April 16, the meeting was called to order by President A. N. DENMAN and an address of welcome was delivered by Mr. JACOB, Mayor of Louisville Mr. J. H. DECKER, Secretary and Treasurer, submitted his report. One member had been lost by death. During the year there were gained 24 active and 7 associate members, and 7 active members and 1 associate resigned. A total of 5 members was gained during the twelve months. There are now enrolled 1 honorary, 223 active, and 56 associate members, making a total of 280. The receipts were $972.60. The annual disbursements leave in the Treasurer's hands $23.18, against $171.50, which was he balance last at the meeting.

President DENMAN next read his introductory address, which we abstract in another column.

At the afternoon session the following papers were read and discussed: "Water-Works Records," J. M. DIVEN (printed elsewhere); "Flushing Street Mains," H. W. AYRES; "Increased Revenue from Private Sources," C. N. PRIDDY; "Use of Liquid and Gaseous Fuels," L. H. GARDNER, (printed elsewhere); "Pressure Regulators for Water-Works," W. RYLE. The following matters suggested by the Question Box were discussed: "How can Water Waste be Stopped?" "Is Steel ¼-in thick sufficient for Boilers 60 ins. x 18 ft. with an Average Pressure of 75 to 80 lbs.?" The evening session was occupied by the reading and discussion of Mr. EDWIN DARLING'S paper on "The Use of Water Meters," (printed elsewhere).

On April 17 Mr. EMIL GEYELIN, of Philadelphia, read a paper on "Analysis of Mechanical Filter Action." Mr. FRANK POND was not ready with his contribution to water literature, but a general discussion was got up on the subject of breakage in sewers, and who should bear the consequence. In the afternoon the water-works were inspected.

At the morning session of April 18, the first paper read was on "Standard Water Pipes," by D. D. RUSSELL, of St. Louis, and on his motion a committee was appointed to establish a standard of weights for water pipe. Mr. Russell, Dennis Long & Co., and the Shickle, Harrison & Howard Iron Co., of St. Louis, were named as the Committee. A paper on "Relations between Plumbers and Water Companies and Departments," was read by Maj. B. F. JONES, of Kansas City, and started a lengthy discussion. Prof. J. B. JOHNSON'S paper on "Aeration and Sedimentation of Muddy River Water," not being ready, Mr. RUSSELL was asked to give some information as to the basins at St. Louis, this being the subject of which Prof. JOHNSON had been expected to treat. A good deal of discussion and questioning ensued, and Mr. RUSSELL, in replying, said that the most effective way of purifying water was by still-water basins. Four basins are continually used for that purpose, except when one is being cleared. The mud deposit, which has to be removed by manual labor, has been known to accumulate to the extraordinary depth of 6 ft., but usually it is not allowed to become more than 18 ins. deep. Mr. CAMERON, of Memphis, asked why they could not bore into the earth and obtain pure water, thereby avoiding all that necessary labor and expense. He said that was the way in which the Memphis people obtain their water.

A paper on "Purification of Water for Boilers" was read by Secretary DECKER, in the absence of the author, F. W. GERECKE, of Chicago.

The United Tramway Sprinkler Co. gave an exhibit of the operation of the Gathright sprinkler car for the benefit of the association. The report of the Committee on Electricity for Preventing Scale in Boilers was ordered printed. The place for the next meeting was then voted on and Chicago was selected. Mr. NEVINS, President of the New England Water-Works Association, gave a general invitation to the convention of his association in June.

The following officers were elected:

President, J. H. DECKER, Salina, Kan.

Vice-Presidents, W. G. RICHARDS, Atlanta, Ga.; WM. RYLE, Paterson, N. J.; H. G. HOLDEN, Nashua, N. H.; W. L. CAMERON, Memphis, Tenn.; C. N. PRIDDY, Leadville, Col.

Finance Committee, JAMES P. DONAHUE, Davenport, Ia.; WM. MOLIS, Muscatine, Ia.; W. S. HAMILTON, Youngstown, N. Y.

Secretary and Treasurer, J. M. DIVEN, Elmira, N. Y.

In the evening the banquet was held, closing the convention, but on the following day an excursion was made to the Mammoth Cave at the invitation of Dennis Long & Co., of Louisville. A meeting was held in the cave on Saturday, when several members were added to the active list and the members remaining on the return to Louisville presented, through Col. L. H. GARDNER, of New Orleans, a handsome after-dinner set of Royal Worcester ware to Mr. CALLAHAN, of the firm of Dennis Long & Co., in token of their appreciation of his generous and untiring efforts in behalf of the interests of the association while in Louisville.

Among those present were the following gentlemen:

ACTIVE.

H. W. Ayres, Hartford, Conn.; Joseph A. Bond, Wilmington, Del.; J. G. Briggs, Chicago, Ill.; Calvin S. Brown, New York, N. Y.; Wm. B. Bull, Quincy, Ill.; W. L. Cameron, Memphis, Tenn.; Edwin Darling, Pawtucket R. I.; J. H. Decker, Salina, Kan.; A. N. Denman, Des, Moines, Ia.; J. M. Diven, Elmira, N. Y.; Jas. P. Donahue, Davenport, Ia.; L. H. Gardner, New Orleans, La.; W. S. Hamilton, Youngston, Ohio; W. T. Harris, Jackson, Tenn.; J. W. Henion, Minneapolis, Minn.; H. G. Holden, Nashua, N. H.; Chas. Hood, Burlington, Ia.; Geo. Hornung, Newport, Ky.; B. F. Jones, Kansas City, Mo.; R. M. Jones, Wyandotte, Kan.; H. E. Keeler, Chicago, Ill.; A. F. Kent, Jamestown, N. Y.; P. H. Linneen, Lockport, N. Y.; A. H. Martine, Knoxville, Tenn.; W. J. Milner Birmingham, Ala.; Wm. Molis, Muscatine, Ia.; Frank F. Moody, Minneapolis, Minn.; A. G. Moore, Cincinnati, O.; Philip Morley, East Liverpool, O.; B. R. Morton, Newport, Ky.; Chas. N. Priddy, Leadville, Col.; W. G. Richards, Atlanta, Ga.; S. Russell, St. Louis, Mo.; Wm. Ryle, Paterson, N. J.; August Schaefer, Maysville, Ky.; Frank Schefold, New Albany, Ind.; F. W. Sheppard, New York, N. Y.; Matt. Stookey, Belleville, Ill.; John W. Taylor Newcastle, Pa.; J. S. Walker, Birmingham, Ala.

ASSOCIATE.

Addyston Pipe & Steel Co., Cincinnati, O.; Chapman Valve Mfg. Co., Indian Orchard, Mass.; J. B. Clow & Sons, Chicago, Ill.; Columbus Water-Works, Columbus, Ohio; Deane Steam Pump Co., Holyoke, Mass.; Galvin Brass & Iron Works, Detroit, Mich.; Holly Mfg. Co, Lockport, N. Y.; Hall Electric Pump Co., Plainfield, N. J.; Hersey Meter Co., Boston, Mass.; Jewell Pure Water Co., Chicago, Ill.; E. H. Kellogg & Co., New York, N. Y.; Dennis Long & Co., Louisville, Ky.; Ludlow Valve Mfg. Co., Troy, N. Y.; W. H. Marsh, New York, N. Y.; A. W. Morgan, Buffalo, N. Y.; H. Mueller, Decatur, Ill.; National Meter Co., New York, N. Y.; National Tube Works Co. McKeesport, Pa.; Newark Filtering Co., New York, N. Y., Wm. Oliphant, Jersey City, N. J.; Rouse & Hills Co., Cleveland, O.; Shickle, Harrison & Howard Iron Co., St. Louis, Mo.; Union Water Meter Co., Worcester, Mass.; R. D. Wood & Co., Philadelphia, Pa.; H. R. Worthington, New York, N. Y.

RAILWAYS.

EAST OF CHICAGO.—Existing Roads.

Housatonic.—Upon the petition of this company for permission to construct a parallel railway to the New York, New Haven & Hartford from New Haven to New York City, the railroad committee of the Connecticut Legislature have submitted a majority and a minority report.

The majority report opposes the petition of the Housatonic and takes strong ground against the construction of parallel railway lines in general. The minority report favors the granting of the petition. The fight will be continued in the Legislature.

Detroit, Lansing & Northern.—The twelfth annual report of this Michigan company shows a decrease in net earnings for the past fiscal year of $166,726. There was a decrease of 42,766 tons in the freight carried, or about 9¾ per cent. The balance sheet shows a total valuation of $9,943,306.

Mt. Gretna.—A dispatch to the Philadelphia *Press* from Lebanon, Pa., says:

The work of grading the inclined railway from Mt. Gretna park to the summit of Gov. Dick mountain is progressing rapidly. Over a mile has been finished ready for ties and rails. The rails will weigh 35 lbs. per yd. and the gauge will be 2 ft. The distance to the top and return will be 7½ miles. The cars will be of the open observation style and will be drawn by a 15-ton engine.

Shepaug, Litchfield & Northern.—A meeting was held at Norwalk, Conn., April 20, to further the extension of this road from Hawleyville to Saugatuck to connect with the New York, New Haven & Hartford. GEO. D. CHAPMAN, of New York, who claims to own a controlling interest in the road, said that the extension will be built if a subscription of $100,000 is raised by the people along the route. Surveys are to begin very soon and it is promised to complete the line within 12 months.

Zanesville & Ohio.—It is proposed to extend this road from its present terminus at Marietta, O., across the Ohio river, and thence to the Gilmer County coal fields, about 57 miles. A meeting to discuss the proposed extension was held at Harmsville, W. Va., April 17.

Schuylkill & Lehigh.—The formal transfer of this road, just placed under construction, to the Lehigh Valley R. R. Co. was recorded at Pottsville, April 23.

Toledo, Saginaw & Mackinaw.—It is generally believed that this Michigan road from East Saginaw to Durand, 39 miles, will soon be transferred to the Michigan Central.

New York & Massachusetts.—Of the two surveys made for the extension from Boston Corners to Westfield, Mass., the route via Great Barrington has been abandoned. A new survey is to be made from a point between Ancram and Tanner's, N. Y., crossing Laconic range by a half-mile tunnel and the Housatonic river at Housatonic.

Valley (Ohio).—The reported purchase of this road by ANDREW CARNEGIE and others is again exciting interest.

Wheeling & Lake Erie.—Tracklaying has begun on the extension from Bowerston to Martin's Ferry, O., and it is expected that trains will be running over the line by Aug. 1.

Louisville, New Albany & Chicago.—It is announced that surveys are to be started in a few weeks for a new line from a point 10 miles north of New Albany directly to Indianapolis. The new line will parallel the Jefferson, Madison & Indianapolis Ry., a part of the Pennsylvania system, and will shorten the "Monon" route between Chicago and Louisville about 40 miles.

Hartford & Connecticut Western.—Funds have been raised for the extension from Tariffville, Ct., to Springfield, Mass., and the application to the Connecticut legislature for permission to mortgage the road to raise funds has been withdrawn. Actual construction will probably begin within 30 days.——The Poughkeepsie & Connecticut R. R., from the east end of the Poughkeepsie bridge to Silver Nails, on the Hartford & Connecticut Western will be in operation by May 15.——The track of the Hudson Connecting road is just completed from Campbell Hall to Modena.

New York, New Haven & Hartford.—Work is to begin soon on an extension of the Harlem River branch from New Rochelle to Port Chester, N. Y.

Concord.—The contract for extending the Suncook Valley Ry., from Pittsfield to Barnstead, N. H., has been awarded to Geo. L. Theobald, Daniel Hazleton, and D. K. Abbott of Concord, and S. S. Ordway, of Suncook. The work is to be completed by June 1, 1889.

Wabash Western.—Engineer E. M. MERRIWETHER has begun surveys for the proposed cut-off from Peru to Laketon, Ind., or some other point on the Eel river. Two or three routes are to be examined.

Lancaster & Hamden.—A corp of surveyors under E. P. BUELL began work at Circleville, O., on April 17.

New York, Lake Erie & Western.—Work is to begin at once on a belt line at Rochester, N. Y., connecting this road with the Western New York & Pennsylvania line.

Grand Southern (New Brunswick).—This road has been transferred to its new owners and will be under the management of WALTER LAMB, assisted by F. W. HOLT. Recent legislation enables the company to borrow $800,000, which will be spent in building a bridge across the St. Croix river and extending the line to Bar Harbor, Me.

New Brunswick & Prince Edward.—This line now extends from Port Elgin to Sackville, N. B., 20 miles. A 5-mile extension is projected to Wird Point. JOSIAH WOOD, of Sackville, is President.

Pennsylvania.—A press dispatch states that "secret surveys" are being made for a branch to McKeesport, Pa.

Somerset. — Tracklaying is in progress on this Maine road from Embden to Carratunk Falls and will be finished in about a fortnight. It is reported that the contract for grading from Solon to Bingham has been let to Contractor Mills, of Norridgewock, Me.

American Midland.—Tracklaying is in progress from Findlay, O., east toward Tiffin, and it is expected that trains will be running to Ft. Wayne on the west and to Tiffin on the east by July 4.

Projects and Surveys.

Hornellsville & West Union. — HARLO HAKES, of Hornellsville, N. Y., writes us as follows concerning this enterprise:

This road is to run from Hornellsville via Canisteo and Greenwood to West Union, a distance of 16 miles. The surveys have been made and the greater part of the right of way secured. The route as surveyed affords easy grades and curves. The company was incorporated in March, 1889. BENTON MCCONNELL is President, and C. H. WICKHAM is Chief Engineer.

Citizens'.—A charter has been applied for by this company empowering it to construct a railway between any two points in Delaware and to build branches from the main line to any other place within the counties through which the road may pass. Power is also given the company to pass over any street or road in the State. It cannot consolidate with any other company or charge more than 3 cents a mile for passenger traffic.

Canada.—Resolutions are before the Dominion Parliament to grant subsidies to the following railway companies: To the Ontario & Pacific, for a line of railway from Cornwall to Perth, a subsidy not to exceed $262,400; to the Ottawa & Gatineau, for a line from Hull Station toward Lac Desert, a subsidy not exceeding $320,000; to the Cap Rouge & St. Lawrence, for a line between Cap Rouge and Quebec, 12 miles, $32,000 per mile; to the Parry Sound Colonization Co., for 40 miles of their railway from Parry Sound to Sandridge, $32,000 per mile; for a railway from St. Andrews to the Canadian Pacific or any point east of the town of Lachute, Argentine county, P. Q., 7 miles, a subsidy of $32,000 per mile; for a railway from Truro to Newport, Nova Scotia, 49 miles, a subsidy of $156,800; to the Central R. R., of New Brunswick, for a line from Grand Lake to the Intercolonial Ry., a subsidy of $328,000; to the Albert Southern, the balance remaining unpaid of a former subsidy, not exceeding in the whole $31,771; to the Baie des Chaleurs, a balance of $244,500; to the Irondale, Bancroft & Ottawa, for a line from the Victoria branch of the Midland Ry., to the village of Bancroft, the balance of a former subsidy not exceeding in the whole $745,000, and to the Northern & Pacific Junction, running from Gravenhurst to Callender, the balance of former subsidies, amounting to $35,000. Work upon all lines to which subsidies are granted shall, unless already commenced, be commenced within two years, and the line shall be completed within a reasonable time, not to exceed four years.

Quarryville & Oxford.—Chief Engineer S. C. SLAYMAKER is making a survey for a railway to run from Quarryville, Lancaster county, Pa., to Oxford, a distance of about 16 miles.

SOUTHERN.—Existing Roads.

Birmingham, Sheffield & Tennessee River.—The Sheffield & Birmingham railway, extending from Sheffield to Jasper, Ala., 37 miles, has been sold to ALFRED PARRISH, of Philadelphia, who has given the road the above name.

Louisville & Nashville.—It is reported that this company is obtaining right of way for a branch to Tuscaloosa, Ala. The erection of a $75,000 union depot at Lexington, Ky., is under consideration.

Monongahela River.—The Parkersburg Construction Co. has sublet contracts for building this West Virginia road as follows:

Ryan & McDonald of New York, sections 4 to 15; Thos. J. Steer & Co., Parkersburg, W. Va., sections 16 to 21 Stanley & Co., of Ohio, sections 22 to 31; F. Blodgett & Co., Parkersburg, section 3 and the river bridge. Sections 1 and 2 embrace the Gaston railway already in operation. Work under the contracts is to begin at once. J. A. Sturm & Co., of Ohio, were awarded the contract for all the first-class masonry. Chief Engineer FICKINGER has started the surveyors over the line to run cross-sections and attend to other preliminaries. Mr. H. N. ROBERTS, Resident Engineer, has superintendence of the office details. It is claimed the road will be in operation before next January.

President J. N. CAMDEN, Jr., has resigned the Treasurership of the Ohio Valley Ry. Co. to devote all his time to this company.

Alabama Midland.—Tuscaloosa, Ala., has raised the $90,000 subsidy asked, which ensures the extension from Montgomery to Tuscaloosa.——It has been decided to make the junction with the Northwest & Florida Railroad at a point 18 miles south of Montgomery.

Richmond & Danville.—The Western North Carolina extension has been completed to West's, Cherokee Co., N. C., 24 miles east of Murphy, to which point the road is being constructed.

Charleston, Cumberland & Chicago.—An election is soon to be held at Abbeville, S. C., to vote on the proposed subsidy of $30,000 to ensure the extension of this line to that place.

Kentucky Central.—It is stated that the new machine shops have been finally located at Paris, Ky. The cost of the new shops is set at $200,000.

Covington & Macon.—Surveys have begun for the proposed branch from Machen via Jackson to Griffin, Ga. The line will follow the partly graded roadbed of the Madison, Griffin & Monticello railway.

Atlantic & Danville.—The company has proposed to extend its line from Danville to the mineral fields of southwest Virginia if the city will subscribe $300,000 to the stock of the company. Work will begin within 30 days after the subscription is voted and the road will be finished on or before Dec. 1, 1891. The subscription is to be payable in $5,000 instalments as each four-mile section is completed.

Atlanta & Florida.—Another proposal has been made for the purchase of this Georgia road by Messrs. Sully, Barg and Dow of New York City, who are the chief owners of the Chattanooga, Rome & Columbus Ry.

If the offer is accepted, a line will at once be built from Cedartown to Atlanta, 50 miles, and from Culloden, on the Atlanta & Florida, to Macon and thence probably to Savannah.

Ocean View.—STACY VAN AMRINGE, of Wilmington, N. C., President, writes us as follows:

This road which runs from the eastern terminus of the Wilmington & Sea Coast R. R., near Wilmington, N. C., along the ocean beach, a distance of two miles, has been completed and will be opened for traffic May 1, 1889. There is a 750 ft. bridge across Wrightsville Sound. The principal business of the road will be the summer travel to the sea coast.

Projects and Surveys.

Decatur, Chesapeake & New Orleans.—The Tennessee and Alabama divisions of this road have been consolidated and the contracts for grading will be let soon. G. C. SANDUSKY, of Shelbyville, Tenn., is President.

Camden, Chester & Gaffney City.—Gaffney City, S. C., has voted $20,000 in aid of this enterprise. It is announced that surveys will begin at once, and the road be pushed rapidly to completion. J. V. SARRATT, of Chester, S. C., is President.

Orangeburg & Lewisdale.—There is a prospect that this road may be completed. It is stated that Northern contractors have offered to furnish rails and equipment if the people along the road will grade it. The road was projected to run from Orangeburg, S. C., to Prosperity, a distance of 60 miles. H. T. PEAKE, of Vance's, S. C., is Chief Engineer.

Middlesborough Belt.—The Middlesborough Town Co., of Bell county, Tenn., invites proposals for the building of a belt line of railway, to encircle the Valley of Yellow Creek and the town of Middlesborough. The length of the road will be about 12 miles. ALEXANDER A. ARTHUR, of Knoxville, Tenn., is interested.

Marietta & Alpharetta.—T. L. LEWIS, B. F. SIMPSON J. P. BROOKE and others, of Alpharetta, Ga., are agitating the construction of a railway between that place and Marietta, Ga., a distance of about 18 miles.

St. Augustine & North Beach.—Organized in Florida with VIRGIL POWERS, of Macon, Ga., President, E. B. WATERS, of Augusta, Ga., Vice-President, and C. W. HENDRICK, Secretary, to build a railway from St. Augustine to the coast.

New Smyrna & Ocean Beach.—Organized in Florida with a capital stock of $25,000 to build a railway from New Symrna to the coast.

Cleveland & Lula.—A company has been chartered in Georgia to build a railway from Cleveland to Lula, a distance of about 15 miles. W. B. BELL, of Cleveland Ga., is president.

THE NORTHWEST.—Existing Roads.

Sault Ste. Marie & Southwestern.—Mr. N. C. FOSTER, of Fairchild, Wis., president of this company, sends us the following information regarding the progress of work on this road:

The preliminary lines and locating survey of this road were run last fall from Rhinelander, Wis., to Eyota, Minn. The line is projected to extend across the Mississipi and southwest to Sioux City and Omaha, a total distance of 525 miles. The line as surveyed will have ½ per cent. maximum grades and 3° maximum curves. The Mississippi river will be crossed at Alma, Wis. About 100 miles right-of-way and local aid from all towns along the route has been secured. Fifteen miles are now in operation, additional contracts will be let at once, and we expect to begin tracklaying in 30 days and complete 25 miles more about July 1. JAS. MCINTIRE is Chief Engineer.

Milwaukee, Lake Shore & Western.—The annual report of this Wisconsin company shows the following results of operations for 1888:

Gross earnings	$2,849,772
Operating expenses and taxes	1,745,007
Fixed charges	608,898
Surplus	$ 495,866

The iron ore transported by the company during the year comprised 59.9 per cent. of the total freight traffic. The percentage of lumber and other forest products was 27.3. The Rhinelander cut-off is to be pushed to completion as fast as possible.

Pacific Short Line.—Over 80 contractors submitted bids for the section of 100 miles from Sioux City westward and the contract was awarded to E. P. Reynolds & Co. of Wymore, Neb.

Grand Tower & East Cape Girardeau.—Johnson Bros. and Haught & McPherson, the contractors on this southern Illinois road, expect to complete their work by September 1. E. A. HITCHCOCK, St. Louis, Mo., is President; J. D. PETERS, Carbondale, Ill., is Secretary.

Northern Pacific & Manitoba.—Work on the Morris & Brandon branch will be resumed early in May. An effort is being made to induce the company to build the line south of the Tiger Hills.

Chester & Centralia.—The tracklayers on this Illinois road have reached a junction with the St. Louis, Alton & Terre Haute R. R. near Coulterville, Ill.

Milwaukee & Northern.—About 500 hands and 6 teams are at work on the extension of the Ontonagon & Brule River R. R., and it is expected to complete the line to a junction with the Duluth, South Shore & Atlantic by August 31.

St. Louis, Alton & Springfield.—A new cut-off has been surveyed to reach Plaza Bluffs, a suburb of Alton, Ill.

Kansas City, Independence & Lee's Summit.—It is announced that the construction of this road will begin soon and the road be completed during the present season. The road is to run from Kansas City to Lee's Summit, a distance of 18 miles. WM. B. KNIGHT, of Kansas City, Mo., is Chief Engineer.

Alberta & Athabasca.—The negotiations for obtaining English capital to build this road in the Canadian Northwest have failed, unless a Government cash subsidy can be secured; and of that there is very little prospect.

Projects and Surveys.

Pekin & Bartonville.—Incorporated in Illinois to build a line of railway from Pekin, Tazewell county, via Bartonville, to Peoria, a distance of about 8 miles. The general offices will be at Pekin. Among the incorporators are: THOMAS COOPER, A. B. SAWYER, A. G. WALKER, I. N. MUNSON and others, of Pekin, Ill.

Yankton & Norfolk.—It is stated that this company has promised to have its proposed road completed by July 1, 1890, on condition that the people of Norfolk, Neb., subscribe for $30,000 of bonds. It is thought that this amount will be easily raised.

Soo & Southwestern.—Incorporated in Wisconsin to build a line of railway near Alma, 2 miles in length. The incorporators are N. C. RUST, W. A. RUST, and JAS. C. MCINTIRE.

Chicago, Freeport & Sioux City.—The surveys of this line are nearly completed, and it is announced that construction will begin early in May. A. L. BRINK, of Warren, Ill., is interested.

Lake Superior Terminal.—JOSEPH SELLWOOD, JAS. T. HALE, JOHN P. MORROW, and others, of Duluth, Minn., have chartered a company by this name to build one or more lines of railway along the shores of Lake Superior and Superior Bay, within a radius of 50 miles of Duluth.

Sparta & Ste. Genevive.—Incorporated in Illinois to build a railway from a point on the main line of the Centralia & Chester R. R. west of Sparta, Ill., to a point on the Mississippi river opposite Ste. Genevive, Mo., about 23 miles. Among the incorporators are THOS. F. ALEXANDER, D. P. BARKER, J. E. GASTON, and others, of Sparta.

Alberta & Northwestern.—It is announced that the Canadian Parliament will grant a land subsidy of 10,000 acres per mile to this company, and that construction will be begun immediately.

THE SOUTHWEST.—Existing Roads.

Galveston & Western.—This company has been reorganized with a capital stock of $240,000 distributed among 40 shareholders. It is the intention of the company to construct its lines down the island and to bridge the bay to the mainland, where connection will be made with the East & West Texas, and the San Antonio & Aransas Pass railways, thus securing for those lines an entrance into Galveston. Another line is to be built to the mouth of the Brazos in the event that deep water is obtained at that point. LELAND H. BLUM, J. H. BURNETT, and others of Galveston, Tex., are interested.

Denison & Washita Valley.—The surveys of the Oklahoma line of this road from Fort Reno to the Pottawatomie line have been finished. From the border the surveys will be extended to McAllister, Ind. Ter., and the road will be pushed rapidly to completion.

Missouri Pacific.—The Chamber of Commerce of Kearney, Neb., has employed engineers to survey three routes for a railway between that city and Prosser, the present terminus of a branch of the Missouri Pacific system. The cost of the different lines will be ascertained; and should the Missouri Pacific decide not to make the extension, a local company will be organized to build the line.

Red River, Sabine & Western.—The Fort Worth Construction Co., of Fort Worth, Tex., which has the contract for grading the first 40 miles of this road, is reported to have commenced work on their section.

Houston, Central Arkansas & Northern.—A press report states that work is in progress on this road near Monroe, La., 25 miles each way being under construction. Of this, 3 miles is graded, ties are distributed and 121 cars of steel rails are on hand. W. A. BRIGHT, of Little Rock, Ark., is President.

San Antonio & Aransas Pass.—The bridge across the Brazos on the Houston branch of this line is completed, and it is expected that regular trains will be running over the line in a few days. It is stated that engineers will be put in the field by May 10 to locate the extension from Houston to the Louisiana State line near Alexandria, and that construction will begin as soon as a sufficient length of the line has been located.

Projects and Surveys.

Marion Belt & Chingawassa Springs.—O. C. LESUR, of Marion, Kan., Chief Engineer, gives us the following information:

This company was incorporated Jan. 25, 1889, for the purpose of constructing a railway from Marion to Chingawassa Springs and the stone quarries in the vicinity of Marion and connecting with the Atchison, Topeka & Santa Fé and the Chicago, Rock Island & Pacific Railways. The total length of the road is 5 miles. The road is designed to open up Chingawassa Park as a summer resort and to connect the Marion stone quarries with the large railway systems. The people of Marion have granted a subsidy of $16,000 to the road and the contract for construction will be let April 20. JOHN HALL, of Ft. Ann, N. Y., is President, and C. S. WINSLOW, of Marion, Kan., is Secretary.

Camden & Alexandria.—It is reported that the subsidy asked by this company of the citizens of Camden, Ark., has been raised and that the work on construction will begin within 90 days. C. C. HENDERSON is President and J. W. BROWN is Vice-President; both of Camden, Ark.

Kansas City & St. Joseph Air Line.—Incorporated in Missouri to build a line of railway from Kansas City to St. Joseph, a distance of 50 miles. Among the incorporators are WM. P. VANAKEN, WM. STEWART, E. L. FURNISH, and W. H. REED.

ROCKY MT. AND PAC.—Existing Roads.

Northern Pacific.—Chief Engineer J. W. KENDRICK has decided upon the line through the Homestake Pass for the proposed branch of this road from Gallatin to Butte, 69 miles, as the shortest and cheapest route. Orders have already been given for 66-lb. steel rails, and construction will commence soon.

Union Pacific.—The annual report of this company for 1888 shows the following results of operations in comparison with the previous year:

	1888.	1887.	Inc. & Dec.
Gross earnings	$29,260,824	$28,557,765	I. $703,059
Operating expenses and taxes	19,165,365	17,667,732	I. 1,497,633
Net	$10,095,458	$10,890,033	I. $794,575
Income from investments	916,215	1,030,552	D. 114,337
Total	$11,011,673	$11,920,585	D. $908,912
Other income	41,309	51,644	D. 110,335
Total	$11,052,982	$11,972,229	D. 919,247
Fixed charges	7,033,746	7,078,453	D. 44,707
Balance	$4,019,236	$4,893,776	D. $874,540
U. S. Government	1,134,393	1,305,655	D. 71,262
Balance	$2,884,843	$3,588,121	D. $803,278
Misc. charges	449,704	413,267	I. 36,437
Balance	$2,435,139	$3,274,854	D. $839,715
Losses, branch lines	842,747	329,479	I. 513,268
Surplus	$1,592,392	$2,945,375	D. $1,351,983
P. C. earned on stock	2 61	4.8	D. 2.19

The company's Government debt is now $50,405,901, and to prevent its further growth, money or, securities will be deposited each year with the American Loan & Trust Co., of Boston, Mass. It is stated that the company is considering the building of a branch from Leadville to Aspen, Col., about 30 miles.

St. Paul, Minneapolis & Manitoba.—It is reported that this company will build a road from Missoula, M. T., down Clark's Fork to Pend d'Oreille Lake and Spokane Falls.

Redondo.—Work is being rapidly pushed on this California road, and it is expected to have it completed by July 15. It is stated that the ties, rails and rolling stock have all been ordered.

Projects and Surveys.

Columbia Valley & Goldendale.—The surveys for this Washington Territory road have been completed from Goldendale to Pasco, and a favorable route is reported to have been secured. The estimated cost of construction and equipment is $1,850,000.

FOREIGN.

Australia.—It is announced that the promoters of the enterprise to build a line of railway in Western Australia, about 800 miles in length, have made agreements whereby they are to receive from the Government a subsidy of 20,000 acres for each mile of road built. It is expected that it will take 10 years to build the road.

Japan.—The Japan Railway Co. has received permission from the Government to double-track its line between Uens and Ourya.

Sonora, Sinaloa & Chihuahua.—Richards, Clegg & Co., who have the contract for building this Mexican road from Guaymas to Topolobampo, 220 miles, have begun work at Guaymas, and it is expected to complete the road to Topolobampo within 18 months. The road is projected to run from Deming, N. Mex., via Las Palomas, Casas Grandes and Piedras Verdes to Guaymas, on the Pacific coast, about 1,500 miles.

Panama.—The annual report of this company for 1888 shows as follows compared with the previous year:

	1888	1887
Gross earnings	$3,690,659	$3,389,583
Operating expenses	2,540,114	2,869,750
Net earnings	$1,150,545	$519,833

RAPID TRANSIT.

Street Railways.—*Rochester, N. Y.*—On April 30 the franchises applied for by the South Park Ry. Co. and the Cross-Town Railway Co. will be sold at public auction. On May 1 another franchise will be sold. Address PETER SHERIDAN, City Clerk.

Tiffin, O.—The street railway has been purchased by Massachusetts parties for $35,000.

Parkersburg, W. Va.—The Park City Street Ry. Co has commenced work; ties have been purchased. Capt. SHAW is the Superintendent.

Durham, N. C.—Proposals for the extension of the street railway will be received by J. T. Mallory.

Concord, N. C.—The street railway survey has been made by Gordon & Estes, of Lynchburg, Va.

Atlanta, Ga.—The Union Street Ry. Co. has been organized to consolidate the street railway lines. President, AARON HAAS; Secretary, J. W. CULPEPPER.

Yankton, Dak.—A street railway is to be built by R. F. Pettigrew, of Sioux Falls, and material has been purchased.

Greeley, Col.—A street railway is projected by property owners on Main St.

Ellensburg, Wash. Ty.—A street railway franchise has been granted to J. V. MOFFIT, of Wichita, Kan.

Argenta, Ark.—The Argenta Street Ry. Co. wants track material and equipment.

Dummy Line.—***Decatur, Ala.***—GEORGE F. CONANT, City Engineer, wants proposals for rails and equipment for a dummy line.

Electric Railways.—***Exeter, N. H.***—An electric line to Hampton beach is projected.

Attleboro, Mass.—H. M. Dagget, Jr., has the contract for the electric road.

Long Branch, N. J.—The Long Branch Electric Ry. Co. has been incorporated by D. M. HILDRETH, of Long Branch; R. PERCY DOBBINS, of Philadelphia, and others.

Altoona, Pa.—An electric railway to Hollidaysburg, 4 miles distant, is proposed.

Vicksburg, Miss.—The Vicksburg Street Ry. Co. wil adopt an electric system.

Americus, Ga.—The Americus Street Ry. Co. has been organized to build 8 miles of line. President, Major J. B. FELDER; Secretary, W. E. MURPHY. Capital stock, $50,000.

Topeka, Kan.—The Topeka Rapid Transit Railway, the equipment of which has been done by the Thomson-Houston Electric Co., was put in operation on April 3. It is the longest electric road in the world (14 miles, 70 miles of track). The trial trip was made April 3, with 4 cars filled with invited guests, including the managers and chief officials of the Topeka City St. Ry., and the East and West Side Circle railways; and it was satisfactory to the railway men and the general public. The power station is a two-story building, 100 ft. front and 85 ft. deep, and has a 125-ft. chimney. The power plant consists of 2 Corliss engines of 600 and 300 H.P. respectively, steam for which is supplied by 5 boilers 6 by 16 ft. The electrical apparatus consists of six 80 H. P. Thomson-Houston generators, with switch board and all necessary appliances for the same. The people are enthusiastic over the prospect of better car facilities and more rapid transit, and it is predicted that before long electricity will be in use on all the street railways in the city.

CONTRACTING.

New Croton Aqueduct.—The following proposals for constructing a masonry aqueduct from the new gate house at 135th St. and Convent Ave., to 10th Ave. and 135th St., being Section No. 15½ of the new aqueduct, have been received by the Aqueduct Commissioners, New York: Robert Hanna & Co., $28,306.75; R. J. Malone, $30,575.50; W. E. Dean, $31,070; O'Brien & Clark, $32,803.25; Joseph Moore, $39,481. The contract was awarded to Robert Hanna & Co.

Timber and Filling.—The following proposals for 20,000 ft. of spruce have been received by the Dock Commissioners, New York: E. W. McClave & Co., $19.70 per 1,000 ft. B. M.; Joseph W. Duryea, $19.75; Bell Bros., $20; A. M. Dodge & Co., $22.50. The contract was awarded to E. W. McClave & Co.——The contract for dumping 50,000 one-horse loads of filling behind the bulkhead between 75th and 77th Sts., North river, was awarded to Geo. W. Plunkett, at 6 and 10 cts. per load for one and two-horse loads respectively.

Dredging.—The following proposals for dredging 50,000 cu. yds. from the Back basin and docks and redepositing the material in the bay were opened April 16 by N. H. HUTTON, Engineer of the Harbor Board, Baltimore, Md.: Baltimore Dredging Co., Baltimore, 21 cts. per cu. yd.; Lamartine J. Fobes, Baltimore, 21.2 cts.; Canton Dredging Co., Baltimore, 21½ cts. The contract was awarded to the Baltimore Dredging Co.

The following proposals were opened April 17 by Gen. SMITH, U. S. Engineer Office, Wilmington, Del.: In the Susquehanna river: Baltimore Dredging Co., Baltimore, 16 cts. per cu. yd.; Atlas Dredging Co., Wilmington, 16½ cts.; Chester F. Caler, Norfolk, Va., 17 cts.; F. C. Somers, Camden, N. J., 18 cts.; American Dredging Co., Philadelphia, Pa., 18 cts.——In the Maurice river: F. C. Somers, 30 cts. per cu. yd.; American Dredging Co., 35 cts.

Sewers.—The following proposals for constructing sewers at Fort Sheridan, Ill., have been received by Capt. C. P. MILLER, U. S. A., Highland, Ill.: James Sweetser, Chicago, $6,895.28; Walter Fleming, Chicago, $5,800 for lake portion; J. S. Prall, Fort Sheridan, $9,016; John B. Davidson, Lake View, Ill., $9,240; O. C. Davis, Racine Wis., $11,500; John Lyons, Chicago, $11,967; Wm. D. Cox, Fort Sheridan, $13,500 (including lake portion); H. M. Nelson & D. Clarey, Chicago, $17,500; Olof Benson, Chicago, $19,400 (including lake portion); Northwestern Construction Co., Chicago, $22,562.87. The contract was awarded to James Sweetser, but did not include the lake portion, for which no bid was recommended for acceptance.

Water Pipe.—Col. John M. Wilson, the engineer in charge of the extension of the Washington aqueduct, has awarded the contracts for furnishing the iron pipe and castings as follows: half of the 48-in. main, and all of the 36, 30, 24 and 20-in. pipe to the Gloucester Iron Co., of Philadelphia, at $26.57 per gross ton; the remainder of the 48-in. mains to the Camden Iron Works, of Philadelphia, at $27.38 per gross ton; special castings to the McNeal Pipe & Foundry Co., of Burlington, N. J., at $56 per gross ton, all to be delivered in Washington, within six months, in portions. The prices of the several bids were given on page 367.

Watervliet Arsenal.—The contract for the masonry of the new gun foundry at the Watervliet Arsenal, West Troy, N. Y., has been awarded to Stanton & Neary, of Cohoes, at $54,500; about 3,000,000 brick will be used. The contract for the iron work has been awarded to R. F. Hawkins, of Springfield, Mass., at $49,449; and for carpenter work to Charles Duncan, of Troy, at $24,600.

Asphalt Paving.—***Newark, N. J.***—The Street Committee has been petitioned to lay sheet asphalt paving on Broad St. from the stone bridge to Gouverneur St. The pavement will probably be laid.

Albany, N. Y.—City Engineer ANDREWS has presented specifications for the pavement of the market site, with asphalt equal to the best Trinidad asphalt, together with a stipulation to be entered into by the contractor agreeing to defend the city from damages in any action that may be brought against it for infringement of patent. The specifications, including the stipulation, have been approved by the Board of Contract, and proposals advertised for.

Dikes.—The following proposals for repairing dikes in the Nansemond river, Va., were opened April 15 by Lieut. G. J. FIEBEGER, U.S. Engineer Office, Norfolk, Va.: Charles Bliven, Norfolk, Va., $2,999; W. Jameson, Norfolk, Va., $3,150; James H. Cline & D. R. Isaac, Richmond, Va., $4,680.

Cement, Sand and Stone.—The following proposals have been received by the Docks Commissioners, New York City:—For 500 bbls. of slow-setting and 500 bbls. of quick-setting Portland cement: E. Thiele, $2.39½ per bbl. for slow-setting, $2.44 per bbl. for quick-setting: Francis G. Brown, $2.42, $2.42; James Brand, $2.45, $2.45; Erskine W. Fisher, $2.45, $2.50; Empire Warehouse Co., $2.45, $2.55; A. C. Babson, $2.75, $2.75; Marcial & Co., $2.50 for quick-setting only. The contract was awarded to E. Thiele.——For 500 cu. yds. of broken stone: West Shore Trap Rock Crushing Co., $1.75 per cu. yd.; Alexander J. Howell, $1.79; John A. Bouker, $1.80; Brown & Fleming, $1.83. The contract was awarded to the West Shore Trap Rock Crushing Co.——For 300 cu. yds. of sand: Brown & Fleming, 85 cts. per cu. yd.; John A. Bouker, 90 cts. The contract was awarded to Brown & Fleming.——The contract for cutting bottom beds of 28 pieces of coping stone was awarded to James F. Dolan, at $13.50 for each bed cut.

Street Work.—***New York, N. Y.***—The Department of Public Works has awarded the contract for paving Hudson St. from Beach to 14th St., and Canal St. between Hudson and Greenwich Sts., to M. & J. Baird, of E. 63d St. The contract calls for granite blocks to be laid upon a bed of concrete and finished in a manner similar to the new pavement on Fifth Ave. The contractors are to receive $3.65 per sq. yd. for the granite blocks, $1 per cu. yd. for the concrete laid between Beach and Spring Sts., and $3.55 per sq. yd. for the pavement and $1 per cu. yd. for the concrete laid between Spring and 14th Sts. The whole job will cost about $250,000.

Bloomfield, N. J.—The Township Committee has awarded the contract for sidewalks and crosswalks to Martin J. Callahan, at 64 cts. per lin. ft.

Montclair, N. J.—The Township Committee has awarded the contract for macadamizing and repairing roads to Chas. E. McDowell, of Bloomfield.

Philadelphia, Pa.—Mayor FITLER has vetoed the ordinance appropriating $300,000 for paving the streets, for the reason that the bill is contrary to law in directing in detail the expenditure of money appropriated for work generally.

Albany, N. Y.—The Board of Contract and Apportionment has awarded contracts as follows: For paving Elk St., 1,750 sq. yds. of paving and 1,125 ft. of sidewalk: Jacob Holler: 85 cts. per sq. yd. for cobblestone, $1.17 per lin. ft. for sidewalk, 42 cts. per sq. yd. for relaying flag and brick, 61 cts. per lin. ft. for new curb, 25 cts. per sq. yd. for repaving and bridge stone, 15 cts. for relaying old curb, 42 cts. per sq ft. for crosswalk, 87 cts. per lin. ft. for circular curb.——For 690 ft. of sidewalk on Livingston Ave.: Jacob Holler, $1.35 per lin. ft. for sidewalk, 42 cts. for relaying brick, 61 cts. per lin. ft. for new curb.

Street Cleaning.—The Board of Contract and Apportionment, Albany, N. Y., has awarded contracts for removing street dirt to Thomas B. Lynch, at 50 and 60 cts. per load; Ezra Bush, 64 cts., and P. H. Reilly, 65 cts.

PROPOSALS OPEN.

Court House and Jail.—At Florence, S. C. Architects, BRUCE & MORGAN, of Atlanta. JAMES ALLEN, Secretary, Court House Commissioners, Florence, S. C. May 1.

Cranes.—Two 30-ton traveling cranes and one 50-ton pillar crane. Col. J. M. WHITTEMORE, U. S. A., U. S. Arsenal, West Troy, N. Y. May 1.

Paving Blocks.—About 57,000 large Belgian blocks 400 ft. of 4½-in. curbing and 600 ft. of gutter stone. A. E. SMYRK, City Commissioner, Baltimore, Md. May 1.

Street Work.—Grading, paving and curbing. JAMES BROWN, Comptroller, Allegheny, Pa. May 2.

Pipe and Laying.—Furnishing and laying about 3,000 ft. of 4-in. iron water pipe, with hydrants, gates, etc. A. J. FARGO, Secretary of Water Committee, Easthampton, Mass. May 2.

Harbor.—Works at the entrance of Toronto harbor, A. GOBEIL, Secretary, Dept. of Public Works, Ottawa, Canada. May 3.

Street Material.—Sheet asphaltum, Sioux Falls granite, Colorado sandstone, Woodruff (Kan.) stone, wooden blocks, brick. St. A. D. BALCOMBE, Chairman of Board of Public Works, Omaha, Neb. May 4.

Trestle.—Framing and erecting about 700 ft. of wooden trestle, requiring about 120,000 ft. of timber. CHARLES ELLIS, Jr., Chief Engineer, Columbia, Newberry & Laurens Ry., Columbia, S. C. May 6.

Bridges.—Building 3 iron bridges across Indian creek; 50-ft. span, 26-ft. roadway, 5-ft. sidewalks each side; substructure of tubular piers 12 ft. long by 9 ins. diameter. F. STIMSON, City Engineer, Council Bluffs, Ia. May 6.

New Croton Aqueduct.—Furnishing 16 sluice gates, 3 x 16 ft., at the gatehouse on Section No. 1 of the new aqueduct. JAMES C. DUANE, President, Aqueduct Commissioners, 280 Broadway, New York City. May 8.

Bridge.—Across Yellow creek, near Rothville. An iron bridge with tubular piers, a bridge with wire cables, or a wooden bridge with white or burr oak piling. Span, 80 ft.; approaches, 30 and 50 ft. JOHN A. LEE, County Clerk of Chariton county, Keytesville, Mo. May 9.

Timber.—Sawed spruce timber. THE DOCKS COMMISSIONERS, Pier A, North river, New York City. May 10.

Bridge.—Wood or iron bridge, 425-ft. span, over the Missouri at a point near the Northern Pacific bridge in Meagher and Jefferson counties, cost not to exceed $10,000. Bridge and approaches, or bridge only. Duplicate bids to GEORGE LAMBERT, Chairman of Board of Commissioners of Jefferson county, Boulder, Mont., and A. J STEPHENS, Chairman of Board of Commissioners of Meagher county, White Sulphur Springs, Mont. May 11.

MANUFACTURING AND TECHNICAL.

Locomotives.—The Rhode Island Locomotive Works, of Providence, R. I., have turned out an engine for the Providence & Springfield road.

The Baldwin Locomotive Works, of Philadelphia, Pa., have delivered 1 engine to the Jacksonville Southeastern road, of Illinois, and 2 engines to the Ensley Coal & Iron Co., of Florence, Ala.

The Union Pacific has turned out another engine at the shops at Armourdale, Kan.

The Carolina Beach road, of Wilmington, N. C., has received a new engine.

A 5-ton locomotive is wanted by F. L. Peck, of Hathaway, Tenn.

Cars.—The Laconia Car Co., of Laconia, N. H., has completed 4 passenger cars for the Boston & Maine.

The Pullman Palace Car Co., of Chicago, Ill., has built a very elaborate private car for President Williamson of the Chattanooga, Rome & Columbus.——The company is building 16 cars for the Central Traction Co., of Pittsburg, Pa.

The Ohio Falls Car Co., of Jeffersonville, O., has an order for several passenger cars for the Chattanooga, Rome & Columbus.

The Wagner Palace Car Co., of Buffalo, N. Y., has built a very handsome private car for Mr. Webb, president of the company. Two combination sleeping and reclining-chair cars have been built to run between St. Louis, Mo., and Springfield, O.

J. M. Jones & Sons, of West Troy, N. Y., have shipped 4 street cars to Pittsburg, Pa.

The Standard Oil Co. will erect works at Lima, O., in which to manufacture and repair its tank cars.

Hoisting Machinery.—Messrs. Milner & Kettig, of Birmingham, Ala., have been appointed agents for the Lidgerwood Mfg. Co., of New York City, and will push the sale of the hoisting machinery made by this firm in that section of the country.

The Servis Tie Plates, writes Mr. D. MCENTAFFER, Road Master of the Wheeling & Lake Erie R. R., have been put to the severest test possible on his road. They were placed on a very short lead, leading off on the upper side of a curve, and the lead rails under which the tie-plates were placed were formerly tipped over so that the wheels ran on the inside edge of the rail. Before putting on the tie-plates, he put in new ties and straightened the rail to its proper position, and since October last the plates have held the rails in position without the least signs of drooping. Mr. MCENTAFFER thinks they are just the thing for curves.

Spikes. — The Central Iron & Steel Co., of Brazil, Ind, has put in a plant for making railway spikes.

The Rochester Vulcanite Pavement Co. has elected the following officers: H. H. Craig, George W. Archer, Mathias Kondolf, Bernard Dunn, George Chambers, James D. Casey, Frank S. Upton, E. M. Upton, James Sargent, Valentine Fleckenstein, John Van Voorhis, D. T Hunt, Dr. J. J. A. Burke.

Creosote Works. — It is reported that the Southern Pacific Railroad Co. will about June 1 change its works at Houston, Tex., to use creosote instead of chloride of zinc, as at present.

Spark Arresters.—The Carper Spark Conductor Company has been chartered at Salem, Va., with C. O. LEARY, President; W. GRIFFEN, Vice-President, and W. T. YOUNGER, Secretary, for the manufacture of a patent spark arrester and conductor to be used on locomotives. The capital stock is $100,000.

Indicators.—The Railway Station Indicator Co. has been organized at Staunton, Va., by C. L. COOKE, J. F. WEST, and W. T. MCCUE, for the manufacture of a patent station and train indicator. Capital stock, $50,000.

Car Axle-Boxes. The Krietch Car-Box Mfg. Co. has been organized at Port Townsend, Wash. Ty., to manufacture axle-boxes patented by Mr, Krietch, which are claimed to last longer than ordinary boxes and bearings. President, A. A. PLUMMER; Vice-President, L. B. HASTINGS; Treasurer, JAMES JONES; Secretary, J. F. MCINTYRE; Superintendent, JACOB KREITCH.

The City Gas Saving Co. has been organized at Chicago, Ill., to manufacture governors, etc. ELINER A. KIMBALL, C. J. FORD, and J. P. JOPLIN. Capital stock, $30,000.

Steel Works.—The Redemann-Tilford Co. has bought the Home Steel Works, at Pittsburg, Pa., lately owned by Graff, Bennett & Co., and will remove the plant to Louisville, Ky., to manufacture refined steel by its patented process.

Mr. JAMES E. YORK, of Ashland, Wis., has made a proposition to the Business Men's Association of that city to put in large steel works.

Car Wheels. — The Fowler Steel Wheel Co. is building works at Chicago to make steel by the Robert process. The steel produced will be used wholly in making the Fowler rolled steel wheel. The works will be finished before July 1, and will have a daily capacity of 200 wheels.

The Alabama Car & Foundry Co., of Anniston, Ala., will build car and car-wheel works. JOHN W. NOBLE, H. HORN, and A. L. TYLER are interested. Capital stock, $200,000.

Drop Forgings are made by the Billings & Spencer Co., of Hartford, Conn., from the "Tobin" bronze produced by the Ansonia Brass Co. The material is said to be excellent for parts of engines and machinery which are exposed to corrosion, and where greater strength is required than is afforded by ordinary brass or bronze.

Garbage Cremation.—Garbage crematories will probably be established at Memphis, Tenn., and Houston, Tex.

Buildings.—Constable Bros., architects, have removed from 149 Broadway to 151 Broadway. They are at work on plans for residences.

BRIDGES AND CANALS.

Bridge Notes.—*Phenix, R. I.*—The contract for the new bridge has been awarded to Dean & Westbrook, of New York.

McKeesport, Pa.—The Duquesne Bridge Co. will have surveys made at once, so as to be able to build the bridge as soon as possible.

Lancaster, Pa.—The Willow St. Turnpike Road Co. has received the following proposals for a bridge to replace the one recently destroyed by fire. The bids for iron bridges do not include masonry. Variety Iron Works, Cleveland, O., iron, $1,795; Columbia Bridge Co., Dayton, O., iron, $1,995; Wrought Iron Bridge Co., Canton, O., iron, $2,050; Pittsburg Bridge Co., iron, $2,275; Samuel Stauffer, York, wooden bridge, $1,940; and the following other bids for wooden bridges: Jacob Kauffman, $2,070; G. F. Breuner, $2,147; E. McMellen, $2,349; J. M. Bachman, $2,900. The contract was awarded to Mr. Stauffer, of York.

Pittsburg, Pa.—The County Commissioners have decided to build the following bridges, and proposals were opened April 24. Miller's run bridge, estimated cost, $3,000; Streets run bridge, $3,300; Plum Creek bridge, at Armstrong, $2,500; Saw Mill run bridge, at Fair Haven, $2,500; Bailey's run bridge, East Deer township, $2,000; Montour run bridge, Scott township, $2,000; Little Sewickley bridge, Cochran, $6,500; Potato Green bridge, Marshall, $2,100. The total cost of these bridges will be $23,900.

East Saginaw, Mich.—Contracts have been let for the construction of the new Toledo, Saginaw & Mackinaw Railway bridge across the Saginaw river. The stone work contract was given to Thomas Creswell, of East Saginaw, and the iron work to the Detroit Bridge & Iron Works. The structure will cost about $60,000 and work will commence shortly.

Detroit, Mich.— On May 1 the Board of Engineers, appointed to consider the practicability and necessity of bridging the Detroit river, will meet at the U. S. Engineer Office, of which Col. O. M. POE is in charge.

Lyons, Ia. — The Lyons & Fulton Bridge Co. has been incorporated to build a bridge across the Mississippi between Lyons, Ia., and Fulton, Ill.

Rotheville, Mo.—Proposals for an iron bridge with tubular piers, a wire cable suspension bridge, or a wooden bridge across Yellow creek will be received until May 9 by JOHN A. LEE, County Clerk, Keytesville, Mo. Span, 80 ft.; approaches 30 and 50 ft.

Kansas City, Mo.—FRANK J. O'FLAHERTY, County Surveyor, has awarded a bridge contract to the Kansas City Bridge & Iron Co. at $2,795.

Houston, Tex. — It is proposed to connect the Second and Fifth wards by a new bridge across the bayou.

Waxahachie, Tex.—Messrs. DUNN and HAWKINS have been appointed a committee to receive proposals for a number of bridges.

Winnipeg, Man. — The draw of the new railway bridge over the Assiniboine river has been swung into place.

Quebec, Que. — Arrangements are being perfected to build a cantilever bridge over the St. Lawrence at a cost of $10,000,000.

Pile Bridge.—The following proposals for building a pile bridge across the Neponset river, from Quincy to Boston, were opened April 15 by JOHN P. PRICHARD, Commissioner of Public Works, Quincy, Mass.: E. D. Blackwell, $19,650; B. Young, $20,267; Geo. H. Cavanah, $21,000; Ross & Harris, $21,200; Alex. McInnis, $21,300; J. Shaw & Horace Sias, $21,417; Rivers & Barker, $22,000; J. M. Hays & Co., $22,800; C. T. Derry & Co., $22,866; John Cavanah & Co., $23,000.

Viaducts.—*Los Angeles, Cal.*—The following proposals for a double-track viaduct, 1,500 ft. long, across the Southern Pacific tracks for the Los Angeles Cable Ry. were opened April 18 by the engineer, S. G. ARTINGSTALL, of Chicago, Ill.: Chas. L. Strobel, 5.30 cts. per lb., 6 months time; A. Gotlieb & Co., 5.40 cts., 4 months; Shailer & Schniglau 5.45 cts., 4 months; M. Lassig, 5.45 cts., 4 months. The contract was awarded to A. Gotlieb & Co., to be completed in 4 months.

Albany, N. Y.—Mr. JOSEPH P. MORROW, Secretary of the Hawk St. viaduct commissioners, has been appointed to superintend the masonry and paving on the viaduct. Contractor Brady has started work for the southern approach.

ELECTRICAL.

Electric Light. — *Westerly, R. I.*—A contract has been made with the Westerly Gas Light Co., at $50 per year, for arc lights and $11.80 for incandescent lights. The Westerly Electric Light Co. bid $74.98 and $15.98.

Holley, N. Y.—The Holley Electric Co. has been incorporated and will put in a lighting plant shortly. Secretary, C. W. BLODGETT.

Jamestown, N. Y.—The Western Electric Light Co., of New York, has made a proposition to put in a plant capable of operating 100 arc lamps of 2,000 c. p. each and 15 miles of wire for not to exceed $15,000. At these figures the city has to furnish building and site. Bonds are to be given by the company that the operating expenses will not exceed $4,650 per year.

Fulton, N. Y.—The Citizens' Electric Light Co. will increase its capital stock from $30,000 to $50,000, and it is reported that it may absorb the Schuyler Electric Co.

Harrison, N. J.—The Gas Committee has reported favorably on the proposition of the Leonard & Ellis Electric Light Co., of New York, to light the streets. The company will be required to furnish 60 arc lights of 2,000 c. p. for a term of 5 years beginning June 15. The lights will be furnished at 38 cts. each per night. The Thomson-Houston Co. bid 40 cts.

Alexandria, Va.—The mayor will receive bids until May 1 for electric lighting.

Birmingham, Ala.—The East Lake Land Co. will put in an electric light plant.

Morton, Ill.—The vote has resulted in favor of electric lighting by 65 to 7.

Kirkwood, Mo.—Bids for electric lighting have been received from Mr. C. A. Kitchen, St. Louis Electrical Co., Brush Electric Light & Power Co., and Westinghouse Electric Light Co. The incandescent system is favored.

Iowa City, Ia.—In the suit between the gas company and the electric light company, the court has restrained the former from making a contract with the city for electric lighting.

Portland, Ore.—The Willamette Falls Electric Co. is extending its lines to Oregon City. The two turbine wheels of 600 H. P. each, at the Falls, have been put in position, and 5 dynamos have been received.

Electric Companies.—The Consolidated Electrical Association of Maine has been organized for the purpose of doing general electrical business all over the State. The association succeeded to the business of the Electrical Accumulator Co. The office is in the Mount Desert Block, Bar Harbor, and its officers are as follows: President, GEORGE H. GRANT; Treasurer, H. W. LADD; Electrician and Manager, LUTHER A. LEACH.

The Southern Electric Company, of Baltimore, Md., has been incorporated by James F. Morrison, D. Howard Tuxworth, Frank S. Marr, Alfred J. Carr and David E. Evans. The company has a capital of $100,000, divided into 1,000 shares, the directors for the first year being incorporators. The company is stated to have for its object the manufacture and sale of all kinds of electrical machinery and supplies, electric light, and machinery for building and constructing electric lighting plants.

The Keelyn Electrical Co., of Milwaukee, Wis., capital, $1,000; incorporators, James E. Keelyn, Edward Fitch and William D. Van Dyke.

The Jenney Electric Company has during the past week taken several heavy orders. Among the orders for arc apparatus are those from Sharpsburg, Pa., fifty lights; Marietta, O., seventy lights, and South Pittsburg, Tenn., thirty-five lights.

The Brush Electric Light companies of Boston and Chicago are reported to have been dissolved. Both companies were solvent, and had no liabilities.

WATER AND MUNICIPAL.

Auburn, Me.—A correspondent sends us the following: Owing to rapidly increasing demands from consumers the Auburn Aqueduct Co. is laying a new supply main, of larger size, from the lake to the city, and is otherwise enlarging and strengthening its system. To raise the money necessary to make these improvements the company has sold to Woodbury & Moulton, bankers, of Portland, Me., $50,000 of its last mortgage 5 per cent. bonds at a very satisfactory price to the company. These bonds constitute the only indebtedness of the company and are a first mortgage on property costing in cash over $300,000.

Flushing, N. Y.—The proposition to establish a thorough meter system, made by Superintendent G. A. ROUILLIER, is causing considerable discussion. Water is taken from 5 driven wells put down by Miller & Edwards in 1885. The Government takes water for Willett's Point paying $5,000 a year for the first 2 years and $3,000 a year thereafter. For an excess of 60,000 galls. consumed, exclusive of that used for extinguishing fires, extra rates are charged by meter measurement at the rate of 10 cts. for 1,000 galls. Each of the wells flows between 250 and 300 galls. per minute: 6-in. pipes which inclose others of 4½ ins. diameter, have been driven into the ground by means of a small pile-driver, to a distance of about 50 ft. From 4 to 12 ft. of filling was first encountered, also stone and hard pan; then fine, yellowish-white sand to a distance of 17 ft., then a white, sticky clay to a distance of 25 ft.; after this, coarse sand and gravel to a depth of 38 ft. The sinking of the wells from 17 ft. to 23 ft. was very difficult, owing to the stiffness and tenacity of the clay which formed the stratum, and which, when dry, is almost as hard as stone. The water level at the Flushing works is about 3 ft. above the surface of the ground.

Duluth, Minn.—There is considerable opposition to granting the application of the Duluth Gas & Water Co. for the dissolution of the injunction preventing it from making a connection with the mains of the Superior Gas & Water Co. and furnishing that place with water. It is said that only 24 hours' work are necessary to effect the connection after the injunction is dissolved, the pipes across St. Louis bay being laid up to within a short distance of the Duluth shores. The company has been advertising its bonds in England recently.

Lowell, Mass.—The Water Board, Superintendent of Water-Works, and City Engineer have submitted their reports for 1888. The usual reference is made to the necessity of adopting some means for checking the present waste: almost every water-works report now contains some allusion to this important matter. Water meters are being tried and the putting of a meter for every consumer is suggested. The report of the Superintendent shows the pumpage to have been 1,822,042,490 galls.; 17,484 ft. of pipe were laid, 19 new stop-gates set, and 24 hydrants put in. There were 1,630 meters in use, and the severe cold of last winter caused the freezing of a large number. A diagram of consumption, etc., is given. Appended is the report of the Water Board as to results following the investigations of mechanical filters.

Drainage in Illinois.—The commissioners of the Great Lake Fork drainage district met at Monticello, Ill., April 15, and made their report on the completion of the great dredge boat, main ditch and sub-ditches. The main ditch is 14½ miles long, 25 ft. wide at the starting point, 7 ft. deep, and 40 ft. wide at the terminus. There are 13 sub-ditches, which cost $143,239. The main ditch cost $104,000, making the entire cost $253,239. These ditches have reclaimed thousands of acres of worthless land, and made it worth $40 per acre, in the counties of Champaign, Piatt, and Douglas.

Irrigation.—*Idaho.*—The men employed on the Boise & Nampa canal have got through the hardpan. They have had a hard time of it, as it required a great deal of drilling and blasting, and the progress was necessarily very slow. They say that the work will henceforth proceed more rapidly.

Washington Territory.—The Natchez Canal Co., of Yakima, capital stock, $4,900, has been incorporated by L. L. THORP, JOHN NELSON, and EMANUEL CATO. Its objects are to construct and operate ditches and canals for the purpose of irrigating Natchez valley in Yakima county.

California,—The Drigg Canal Co. has been organized at Fresno, Cal., by H. D. COLTON, B. E. HUTCHINSON and C. G. SAYLE. Capacity, 50 cu. ft. per second. Capital stock, $20,000.——At Independence the Stevens Ditch Co. has been incorporated with a capital stock of $45,000, and a proposition to extend the ditch about 12 miles is being considered.——The directors of the Kraft irrigation ditch, at Orland, Colusa county, have issued bonds for $600,000. ——The directors of the Colusa irrigation district met at Colusa recently, and received the report of the engineer regarding the construction of a canal for irrigating the district. The report says that a canal with a capacity of 450 cu. ft. of water per second will afford an ample supply of water for the needs of the district. This flow is equivalent to 1 cu. ft. per second for each 225 acres in the district. If this flow were maintained for 3 months, it would be sufficient supply to cover the entire district to an average of 9¼ ins. The length of the canal is 39 miles, and the cost would be $400,000, exclusive of the right of way.

San Francisco, Cal.—The following is taken from a San Francisco paper:—Col. WM. J. WELSLEY proposes new water-works for San Francisco. He is reported as follows: "Water can be put in here and used for $6,500,000. I have got the right to the finest water, 80,000,000 galls. a day, in the State; indeed, on the coast. It is the South fork of the American river, and comes from the Sierra Nevadas. We have a canal to within 16 miles of Sacramento. Piping to the city would not cost over $1,500,600. The city can purchase the entire rights, 80,000,000 galls. of water a day, a tract of land of 5,000 acres and the canal for $1,500,000. Putting the water into the houses would not cost over $6,500,000, and the city would have a supply of water sufficient for 1,500,000 population. The cost to the people would be reduced to 7 cts. a thousand feet instead of 18 as at present. The city should be bonded for the amount of the purchase, creating a sinking fund, from which it could be clear in 12 years. I am ready to accept the city's bond for the sum, and will present my water rights, which are indisputable, to the supervisors at their next meeting. Oakland could be supplied from the pipes to this city, and the city would make money in buying the rights. If I cannot dispose of them to San Francisco, a corporation will be formed to supply water at a half less than is paid for it now."

Wytheville, Va.—The contract for the nigh-service water supply has been awarded to the Glamorgan Co., of Lynchburg, Va., for plant complete, at $19,925. The bids were as follows: H. J. Curtain & Co. scheme A, $22,900; scheme B, $19,817; Kirk & Reynolds, Chattanooga, scheme A, $27,450; scheme B, $24,825; H. B. Maupin, scheme A, $22,595, scheme B, $19,645; Glamorgan Co., Lynchburg, scheme A, $19,925, scheme B, $17,973; Porter, Jackson & Co., Chicago, partial bidders; not considered. Hon. CHAS. W. GLEAVES is mayor.

Gas Works at Macon, Ga.—The Consumers' Gas Light Co., which was organized some time ago in the interest of the American Water & Gas Works Construction Co., of Philadelphia and New York, has acquired control of the Macon Gas Light & Water Co, which has been supplying water and gas for several years. The new company manufactures gas under new patents. Legal obstacles prevent a consolidation of the companies, but the plants will be operated together and a uniform price of $1.50 per 1,000 ft. charged instead of 90 cts. as at present. It is claimed that gas cannot be supplied at a profit for less than $1.50. Mr. B. VAN STEENBERGH is General Manager of the new organization.

Meters for Troy, N. Y.—The Water Board has received the report of the special committee appointed to investigate water meters. MR. RANKIN stated that in the fire department alone there was a waste of water to the extent of $5,000, and he favored placing a meter in every public building in the city. The Board decided to buy 30 ¾-in. and 1-in. Crown meters, from the National Meter Co., of New York, and 20 Worthington meters, including the 1½, 2, 3, and 4-in. sizes. The cost of the meters will be $3,079. The meters will be placed in laundries and factories, and all buildings where there is a large consumption of water.

Water Supply and Sewerage of Toronto, Ont.—The report by Messrs. HERING and GRAY on the improved water supply and sewerage was received early in March; the council immediately passed a by-law appropriating $578,000, and this was recently voted on by the property owners, and carried by a vote of 2 to 1. This sum is to be spent in laying a 4-ft. pipe across the bay, providing additional pumping power, and laying some 12-in. mains in different parts of the city for the purpose of increasing the pressure.

Anniston, Ala.—The water-works owned by the Anniston City Land Co. have a pumping capacity of 1,500,000 galls. per day. The company is now making arrangements with a water-works construction company of New York which has examined the plant and will guarantee to increase the supply to 5,000,000 galls. per day, or more if necessary; it will put up large pumps and extend the mains to all parts of the city. The estimated expense is $150,000. The water rates will be at a uniform low rate, and water will be sold by meter measurement when desired.

Water-Works.—***Maine.***—Portland. Mr. J. HERBERT SHEDD, of Providence, R. I., is the engineer for the new reservoir on Munjoy Hill. Mr. J. J. Newman is the contractor.

Massachusetts.—Springfield. The city has petitioned the Legislative Committee on Water Supply for permission to construct an additional main from the source of the water supply in the town of Ludlow.——Easthampton. The Water Committee will open proposals May 2 for furnishing and laying 3,000 ft. of 4-in. pipe, with hydrants, gates, etc. Chairman, G. H. NEWMAN; Secretary, A. J. FARGO.——Wakefield. Woodbury & Moulton, of Portland, Me., have $20,000 of the bonds for sale. The works have been in operation for 5 years.

Connecticut.—New London. The Water Commissioners have received 17 proposals for trenching and laying the new 20-in. main; rock excavation is provided for at $3 per yd.

New York.—Franklinville. The Board of Trade is considering the water-works question.——Skaneateles. The Skaneateles Water Co., which was incorporated about 18 months ago, is taking active steps to tap the lake before its franchise expires, next December. The company proposes to furnish the village with 40 hydrants, giving the village a privilege of buying the plant in 3 years.——Albany. The Water Commissioners have ordered Mr. Andrews, the contractor, to make the test of the new water supply wells without further delay. A contract for boilers has been let to Sullivan & Ehlers. ——Castile. An iron tank, 11 ft. deep, 60 ft. in diameter, and holding 80,000 barrels of water, has been built by the Tonawanda Machine Works for the corporation of Castile. In it will be kept a reserve water-supply for fire purposes. The tank weighs 8,000 lbs.——Canton. Water-works are to be built.——Syracuse. Justice KENNEDY has made a decision overruling the preliminary objection to the condemnation of the lands at Onondaga Valley on which the Syracuse Water Co. has sunk gang wells.——Tarrytown. Proposals will be opened May 4 by S. B. LEACH, C. E., at the office of the Water Commissioners, for constructing stone pumping station, house, distributing reservoir with gate-house, and high-service reservoir; also setting 2 boilers.——Addison. Proposals will be opened May 3 by H. C. HITCHCOCK, treasurer of the water-works, for 48 ft. of 16-in. cast-iron pipe, 4,985 ft. of 10-in., 2,150 ft. of 8-in., 3,605 ft. of 6-in. and 9,225 ft. of 4-in.; 21,000 lbs. of specials; 23 valves; 60 double-nozzle hydrants, 17 valve boxes; also trenching and laying 20,013 ft. of pipe, setting hydrants, etc.; also building reservoir. ——Jordan. New York parties are interested in a water-works project. Their idea is to bring the water in pipes from the Cascade spring on the hills south of the village.

New Jersey.—Madison. It is proposed to establish water-works to supply the villages of Madison and Chatham. Engineers have been over the ground and a public meeting will be held to discuss the matter.——Jersey City. At a recent meeting of the Board of Trade, Engineer L. B. WARD, of the State Board of Water Commissioners, argued against making a contract with any individual or corporation. His views were favorably received, and the meeting passed a resolution that Jersey City secure a new supply of water as soon as practicable, but that the control of the water be kept in the hands of the city.

Virginia.—Hampton. The Hampton Water Co. will pump water from gang-wells to a stand-pipe; there will be 3 miles of mains.

West Virginia.—Lewisburg. Water-works are to be built, and the supply will probably be piped from a spring 1 mile distant.

North Carolina.—Hickory. For particulars of the projected water-works address the mayor.

South Carolina.—Charleston. The pipe laying between the two reservoirs is expected to be completed by May.——Greenville. Water-works are projected. For particulars address the mayor.

Georgia.—Cedartown. A vote on the water-works question will be taken April 29.——Savannah. The Tybee Artesian Water, Ice & Light Co. will establish works at Tybee Id. JAMES H. FURBER, WM. KEHOE and J. J. BUTLER are the incorporators. Capital stock, $5,000.

Alabama.—Jacksonville. The water-works are to be extended. For particulars address J. O. CAMP.——Sheffield. The Sheffield Coal, Iron & Land Co. has organized a company to build new water-works at a cost of $100,000; 3 pumps with a daily capacity of 4,000,000 galls. will be put in, a stand-pipe 80 ft. high built, and 18 additional miles of pipe laid.

Tennessee.—Newbern. For particulars of the projected water-works address the mayor.——Morristown. Water-works have been contracted for.

Kentucky.—Mount Sterling. The Mt. Sterling Water-works Co. has been organized, and has obtained from the City Council a franchise for 30 years, provided the company begins work within 12 months, and completes it within 2 years. The company is now making surveys.

Ohio.—Delaware. Pipe-laying for the water-works was commenced April 16.——Leetonia. Proposals will be opened May 10 by J. S. GREENAMAYER, the mayor, for 40 pieces of 12-in. cast-iron pipe, 57 of 10-in., 667 of 8-in., 1,129 of 6-in. and 600 of 4-in.; 10 tons of specials; 55 double-nozzle hydrants; 45 gates, 3 check valves; trenching and laying 31,000 ft. of pipe; 2 duplex pumps of 750,000 galls. capacity each; 2 boilers; pumping station; 2 reservoirs of 500,000 and 100,000 galls. capacity; collecting basin and conduit.

Indiana.—Covington. A vote on the water-works question will be taken May 7.

Illinois.—Murphysboro. The Murphysboro Water-Works Co. has been incorporated by W. R. JONES, E. F. A. CHAPMAN, and J. HAVEY. Capital stock, $30,000.

Nebraska.—Kearney. The Kearney City Water Co. has increased its capital stock from $125,000 to $300,000.——Omaha. The large reservoir at the Chautauqua grounds is almost completed. The trenches for the pipes have been dug, and the pump is on hand ready to be placed in position as soon as the pump-house is finished. The entire water-works plant will be in running order by the middle of May.

Missouri.—Marceline. The City Council has granted a water-works franchise.——St. Charles. The large tank of the water company, containing 100,000 galls., gave way on April 13. It is said the accident was caused by the settling of the foundation. A steel tank of 600,000 galls. capacity is to be built at once.

Colorado.—Trinidad. The city has purchased the works of the Trinidad Water Co. for $69,000.——Pueblo. The water-works are to be improved and extended, and a new Holly engine of 10,000,000 galls. capacity put in.

New Mexico.—Folsom. It is proposed to bring a water supply to the town from Cimarron river.

Oregon.—Weston. The town has voted to issue $100,000 in bonds for water-works.——La Grande. The La Grande Hydraulic Co. has built a large reservoir, 180 ft. above the city, to furnish a water supply.

Washington Territory.—Coupeville. A water famine is feared unless the water company can get its pipe line completed very soon.——Colfax. D. P. Thompson, of Portland, proposes to put in water-works.

California.—Nevada City. The Trustees have decided not to submit to a vote of the people the question of issuing bonds to purchase the local water-works, the company owning the same having set its price at $35,000, which is considered too high.

Utah.—Ogden. A proposition to purchase the present works, to furnish an ample supply, to replace wooden pipes with iron, and to generally improve the system, has been made to the city by Swan & Holmes, A. S Blake and Robert Robinson.——Salt Lake City. The extensive improvements begun last fall for improving the water supply for domestic and irrigating purposes are rapidly being completed. Much ground above the reach of the old water mains and ditches will now be supplied. Mr. Fox, City Engineer, has made a survey in the interest of Capitol Hill addition, and reports the finest natural advantages for reservoir system anywhere about the city lying within a mile north of this addition.

Canada.—Winnipeg, Man. Two large tanks for the water-works have been completed by Goldie & McCulloch, of Galt, Ont.

Special Reports of Water-Works Construction.

Avoca, N. Y.—The following information has been sent us by F. M. ATWOOD, Chairman of the Water Board:

The village has voted bonds for water-works to cost about $20,000, and E. D. Smalley, of Canastota, has been engaged as engineer. Contracts will be let May 1, work to begin about June 1. The village has a population of about 1,000, and will be supplied by gravity from springs 1½ miles from and 140 ft. above the village. There are to be 30 hydrants.

Palmyra, N. Y.—E. M. BASSETT, of Buffalo, who has charge of the surveys, has sent us the following:

The population of Palmyra is 3,500. The Palmyra Water-Works Co. has contracted with Bassett Bros., Buffalo, to put in works, beginning construction May 1. Water will be pumped from wells and springs to a stand-pipe.

Leetonia, O.—The following details were furnished us by J. S. GREENAMYER, mayor:

Bids will be opened May 10, 1889. Water will be pumped from springs to a reservoir, at a cost not to exceed $50,000, the same to be met by bonds. J. B. STRAWN is Engineer. Population, 3,500.

Barnwell, S. C.—The following data are from the office of L. B. CLAY, Bartow, Ga.:

An artesian well has been sunk for the village by L. B. CLAY, from which water will be pumped to a reservoir. Population, about 3,000. Address D. P. BELINGER, mayor.

Florence, S. C.—The following information is from B. C. STARR, Jr.:

The village has a population of about 4,000, and water-works are being considered. The supply will probably be from an artesian well.

St. Johns, Mich.—The following is from E. E. WHITE, one of the water-works committee:

An artesian well has been sunk 600 ft. with good success, and another well is now being put down. Direct pumping will probably be used. Proposals for $45,000 bonds will be closed May 5. Address JNO. D. HENDERSON, Village President.

Whitewater, Wis.—The following data are from C. E. GRAY, Waukesha, Wis., president of the Whitewater Water-Works Co.:

An artesian well yielding 500,000 galls. a day has been sunk, and from this water will be pumped to a tank 30 ft. in height, placed on an 80-ft. tower. The works will cost about $100,000. The Designing Engineer was JNO. A. COLE, Chicago; the Constructing Engineer is C. E. GRAY; the contractors, C. E. GRAY, Jr. & Co., Chicago. Population, 5,500.